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EDITORIAL.

NOXIOUS WEEDS.

IN this issue will be found the first part of an article on the subject of Noxious Weeds and their Control in Fiji, which summarises the replies to the Questionnaire issued by the Department of Agriculture in March of this year. This subject will be discussed at the Agricultural Convention to be held in Suva at the time of the Fiji Show in October and a further article will be published in a later issue of the *Journal*.

Approval has been given for investigations to be conducted in Trinidad on the insects found by Mr. Simmonds to exercise some control on *Clidemia hirta* in that Island. Readers will remember he called attention to insect agencies other than Thrips which were found by him to attack the seeds and thus check the spread of the plant.

Attention has been called to the increased occurrence of a weed locally known as " Wild Verbena," " Purple Top " or " Purple Weed " (*Verbena bonariensis*) on land in the Wainimala River district. It is recommended that this weed should be pulled out and destroyed wherever it is seen.

Experimental work with sodium chlorate as a spray is being continued at Nasinu. As far as can be ascertained at present *Clidemia hirta* is affected to a greater extent than most of the other weeds, but whether or not it is killed completely remains to be seen. The spray appears to exercise a selective action on the different weeds, some of which are affected much more seriously than others. Lantana, curiously enough, appears to recover completely from the effects after a time, as also does Blue Rat Tail.

COPRA DRIERS.

The Coconut Committee has authorised expenditure on the erection of an inclined chamber copra drier to deal with native copra in a district easily accessible from Suva and plans and specifications are now in course of preparation. Several types of copra driers are in operation in Fiji and these will be made the subject of an investigation in the near future, with the object of evolving a standard type. The design approved for the one to be erected by the Coconut Committee appears to be the best of those hitherto investigated. The drier will be erected in such a manner that minor modifications can be easily effected.

RHINOCEROS BEETLE.

This serious pest of coconuts is increasing rapidly in Western Samoa, owing mainly to the breakdown in the beetle control formerly exercised in that territory. The danger of introducing the beetle to Fiji is thus increased and the matter of instituting more effective preventive measures is under consideration.

NOXIOUS WEEDS AND THEIR CONTROL IN FIJI.

By A. C. BARNES, Director of Agriculture.

PART I.

IN March, 1930, a Circular Letter and *Questionnaire was issued by the Department of Agriculture calling for information regarding noxious weeds in the different provinces of the Colony. Thirty-seven replies were received from the following provinces:—Ba, Bua, Cakaudrove, Kadavu, Lomaiviti, Lautoka, Lau, Macuata, Naitasiri, Nadroga, Nadi, Rewa, Ra and Tailevu. On the whole the response has been good and it is now possible to summarise the position in regard to this serious aspect of local agriculture.

Attention should be called in the first instance to the fact that plants of economic value in certain provinces and for certain agricultural pursuits are regarded as noxious in others. Thus, for example, one may mention Johnson Grass (*Sorghum halepense*, Pers.); Guinea Grass (*Panicum maximum*, Jacq.); Sensitive Grass (*Mimosa pudica*) and Para Grass (*Brachiaria mutica*, Stapf.) are welcomed on pasture land, but are a nuisance in cultivated areas, particularly in the cane districts.

It is difficult from the information at present available to decide in what order of importance the plants regarded as noxious weeds should be set out, for the reason already given and for other reasons dependent on the nature of the soil, climate, rainfall and agricultural pursuits followed in the various provinces.

The following list of plants regarded as noxious weeds has been compiled from the replies received:—

Johnson Grass	*Sorghum halepense*, Pers.
Nut Grass	*Cyperus rotundus*, L.
Guinea Grass	*Panicum maximum*, Jacq.
Prickly Solanum	*Solanum torvum*, Sw.
Guava	*Psidium Guayava*, L.
Ellington Curse	*Acacia farnesiana.*
Vaivai	*Leucaena glauca*, Benth.
Monkey Pod	*Pithecolobium dulce*, Benth.
Noogoora Burr	*Xanthium chinense*, Mill.
Fern	
Koster's Curse	*Clidemia hirta.*
Lantana	*Lantana camara*, L.
Blue Rat Tail	*Stachytarpeta indica.*
Thurston Grass	
Burr (unnamed)	
Sensitive Grass	*Mimosa pudica.*
Para Grass	*Brachiaria mutica*, Stapf.
Mile-a-minute	*Mikania scandens*, Willd.
Chinese Burr	*Triumfetta rhomboidea*, Jacq.
	Ipomoea coccinea, L.
	Ipomoea quamoclit, L.
	Ipomoea quinquefolia, Griseb.
Kaumoce	*Cassia tora*, L.
Burr Grass	*Cenchus echinatus*
Blue Fower (Sigatoka)	*Eleophantis scaber.*
Seed Grass	

* *Agricultural Journal*, Vol. 3, No. 2, 1930.

It will be convenient to consider the question as it affects the different provinces from which replies have been received.

BA PROVINCE.

The only reply received was from the Manager of the Colonial Sugar Refining Company, Limited, at Rarawai, who naturally dealt with the question from the point of view of the cultivator of sugar cane. He gives the following list of weeds occurring in his district:—In Ba–Tavua district—Johnson Grass, Nut Grass, Guinea Grass, Prickly Solanum, Guava, Ellington Curse and Vaivai; on Yaqara Estate—Monkey Pod, Ellington Curse, Guava and Noogoora Burr.

He states:—

Johnson Grass has proved the worst menace in our cultivated lands; it is found in both rich and poorer soils in the Ba District, and is spread in the droppings of stock and also by cane trucks, the seed adhering to oil and grease about the axle boxes. It is kept partially in check in fallow lands by such cover crops as Black Mauritius Bean and Rice Bean, but becomes abundantly evident again after these crops are ploughed under. It adds very considerably to the cost of cultivating sugar cane, entailing hand weeding at frequent intervals during the first six months growth.

The spread of Johnson Grass into our cane areas at Tavua has been prevented by the employment, practically ever since cane growing was started there, of some men whose sole duty is to search for, and eradicate, the grass along the tramlines and in other likely places throughout those areas. This has meant a constant expenditure, but has, without doubt, obviated a general increase in cultivation costs, entailing far greater expense throughout the Tavua District.

Under our conditions of farming, relief from the expense involved in combating Johnson Grass can scarcely be expected unless some method of biological control can be devised.

Nut Grass, although not as serious a pest as Johnson Grass, grows densely in many of our rich river flat areas. Unless kept in check, it seriously effects the "striking" and early growth of sugar cane. In very heavily infested fields, hand weeding at short intervals is necessary until the cane is about two months old. Nut Grass is infested in Fiji by a coccid which is to be found on the shoots at the ground level, and this insect, no doubt, exerts a partial control on its spread.

Guinea Grass is easier to deal with than Johnson Grass, but its eradication can entail heavy expenditure if it is not kept under control. It is spread largely by stock and in the oil and grease on cane truck axle boxes. Eradication must be carried out by digging out and destroying the stools.

Prickly Solanum is assuming menacing proportions in some of our areas along the Ba River. It appears to be spread by the agency of "bulbuls"; it is dealt with by uprooting.

Guava is a pest in land, chiefly on hill slopes, not under cultivation. We are gradually taking some of this land, where practicable, into cultivation by uprooting the Guava prior to ploughing. This is an expensive operation and is best carried out with the aid of tractors.

Ellington Curse is found on land not under cultivation. It appears to be increasingly evident in Ba–Tavua areas, and is dealt with by uprooting.

Vaivai is somewhat troublesome on rich river flats. It encroaches rapidly on the cultivated land and has to be eradicated.

Yagara Estate.—On this estate, Monkey Pod, Ellington Curse, Guava and Noogoora Burr are all dealt with by uprooting, and where practicable, burning. The area under these pests is being materailly reduced each year.

We trust this information will be of assistance to you. It will be observed that two grasses are mentioned which in pasture country would be of value, but in cane country can be a serious nuisance.

BUA PROVINCE.

Four replies were received. The principal crop is coconuts. Noxious weeds mentioned are Koster's Curse, Lantana, Blue Rat Tail, Guava, Fern, and Solanum. Methods adopted are—

(*a*) general clearing;

(*b*) uprooting of individual plants and burning.

In virgin areas it is said that practically no noxious weeds are found. The cost of clearing for cultivation is estimated at from 10s. to £3 or more per acre. Weeds are kept in check on rich land by annual cutting at a cost of upward of £1 per acre. It is stated that the annual cost of main-

taining grazing areas reasonably free from weeds is £1 on good land and 10s. on poor hills. The ravages of uncontrolled animals appear to assist the spread of weeds. One writer states that a reduction in the number of birds would tend to check the spread of weeds. The methods adopted for keeping land free from noxious weeds are clearing and planting with cover crops, such as Rice Bean and Mauritius Bean. One suggestion is that a Local Noxious Weed Board should be formed of landholders with the District Commissioner as Chairman to initiate and carry on campaigns in the different districts for the eradication and control of weeds.

CAKAUDROVE PROVINCE.

Four replies were received. Weeds found are Koster's Curse, Guava, Lantana, Blue Rat Tail, Thurston Grass. The principal industry is coconuts. Weeds not harmful to coconuts, but which interfere with efficient working of plantations are said to be Lantana, Blue Flower, Kaumoce and Sensitive Grass. One writer states that he successfully got rid of Guava on his property by removing all stock, cutting down the trees two feet from the ground and allowing Mile-a-minute to grow over the stumps. The result of this is that there is no Guava whatsoever on the area dealt with. The same writer states that Koster's Curse and Lantana can be dealt with in the same manner in that area. Lantana is said to grow rapidly and thickly on the flat where the soil is good but in other parts is not troublesome. Koster's Curse appears to be increasing. An attempt is being made to smother the Koster's Curse by planting Rice Bean. Lantana and Koster's Curse grow densely on native lands in the vicinity of European-owned estates and render it much more difficult to maintain effective control. Birds are regarded as the main factors which cause the spread of these two weeds. It is interesting to note that another plantation manager states that systematic weeding, grazing of cattle and periodic cutting of Koster's Curse and pulling out Lantana at a cost of 4s. 6d. per acre per annum is effective. Again birds are regarded as the worst offenders in assisting the spread of Koster's Curse and Lantana. Large areas of unoccupied land maintain a constant source of seeds for the reinfestation of clean areas. Still another planter removes harmful weeds by hand at a cost of 38·4d. per acre per annum.

KADAVU PROVINCE.

One reply was received indicating that the area in question is free from troublesome weeds.

LOMAIVITI PROVINCE.

Four replies were received, three from Ovalau and one from Gau. A reply from the Cawaci Mission states that crops grown are yams, taro, bananas, tapioca, sweet potatoes and European vegetables. Weeds appear not to be troublesome. Guava is kept down by regular weeding and Lantana, Mile-a-minute, Blue Rat Tail and a little Koster's Curse encountered are pulled up whenever found. A kind of Burr (unnamed) appears to give a little trouble. Paddocks are kept in order by regular weeding and burning, followed by planting of grass. The work is done by school boys. Apart from the Burr the weeds are not increasing. Cattle are said to contribute very much to the spread of Guava, which is kept under control by cutting down to ground level twice a year. The Burr appears to be a serious pest. It grows fast and the seeds stick to anything which touches them so that it is easily and rapidly spread. Blue Rat Rail is best dealt with by complete uprooting. Mere cutting simply acts as a form of pruning and the plant grows again with increased vigour.

A further reply from Cawatara, Ovalau, is in similar terms to the one dealing with Cawaci.

In cultivated land on the West Coast of Ovalau, Koster's Curse, and Solanum are regarded as serious pests but have been satisfactorily dealt with by chopping down to ground level and ploughing out the roots. The crops grown are maize, coconuts, pineapples, bananas and rice. Weeds are kept in check by periodic weeding and ploughing. The cost per acre of initial clearing is said to be £3.

Gau.—Referring to a coconut plantation the writer reports Guava and Koster's Curse to a small extent, with Blue Rat Tail. All are kept under control by clearing. Cattle are employed to keep the growth under nuts in check. The annual cost of weed control is said to be about 10s. per acre. Guava appears to be slowly increasing though Koster's Curse is kept in check but is likely to increase in the future owing to the heavy infestation of native areas. Kaumoce is said to be a nuisance.

LAUTOKA PROVINCE.

One reply was received, from the Manager of the Colonial Sugar Refining Company Limited, in the form of a general statement as below:—

The most prominent noxious weeds in the canefields and the degree of infestation are described in the following notes of our Mr. Greenwood.

These weeds are dealt with to some extent by the hoe, or in the case of Para Grass by a digging fork and to a greater extent by the use of weed destroying implements, either tractor or horse drawn. In the case of Para Grass on fallow lands, harrowing down and burning followed by one or more shallow ploughings has met with success frequently.

Their growth on fallow lands is checked by bare following with occasional stirring of the soil by implements and by the practice of planting a leguminous green manure crop.

Our unused areas being mostly barren hills do not generally afford a breeding ground for noxious weeds.

Guava has occasionally been troublesome and on land which it it intended to cultivate, cutting down, burning off and ploughing out the roots has been found the most useful way of dealing with it.

NOTES BY WILLIAM GREENWOOD, H.D.A., F.E.S., F.L.S.

Excluding the grasses, some of which are useful for fodder, and the legumes, most of which are beneficial to the soil, there are, in the Lautoka, Nadi and Sigatoka cane areas, about 60 weeds. The majority of these are of no great importance at present and do not occur in large numbers but the cane fields would be better without them. A list of the more important of these weeds with short notes is given below:—

Panicum maximum, Jacq. (Guinea Grass),—This excellent fodder grass occurs in all the three districts under consideration and in the cane fields must be regarded as a weed.

Brachiaria mutica, Stapf. (Para Grass).—Another excellent fodder grass which is a great pest in most low lying cane fields. It is common in all three districts.

Sorghum halepense, Pers. (Johnson Grass).—A bad weed in cane land but only occasionally seen in the Lautoka, Nadi or Sigatoka Districts and at once dug out by the roots and burnt.

Mikania scandens, Willd. (Mile-a-minute).—This climber, although eaten by cattle and recommended as a cover crop to keep down weeds in other parts of the world, is a very bad weed pulling the cane down in our cane fields, more particularly in the Sigatoka District.

Lantana camara, L.—A small patch of this weed was found in cane fields at Lautoka a few years ago and was destroyed. A few scattered seedlings from this patch were found later and were also destroyed and during the last two years no more has been seen.

Triumfetta rhomboidea, Jacq. (Chinese Burr).—This hard woody plant is a common weed in all cane areas.

Psidium guayava, L. (Guava).—Although not a weed in the actual cane fields, this common shrub soon appears in fields which are out of cultivation for a couple of years and on account of having to be grubbed out, much increases the cost of bringing these fields under cultivation again.

Xanthium chinense, Mill. (Noogoora Burr).—This very bad Australian weed was found in the Lautoka District about ten years ago and was destroyed. Various plants were found in the following years over a small area and were dug up and burnt. It has not been noticed during the last two or three years.

Solanum torvum, Sw.—This plant, which was common in parts of Fiji in 1906, is a bad weed on most river bank lands in the Lautoka, Nadi, and Sigatoka Districts, but not in the cane areas.

Ipomoea coccinea, L., *I. quamoclit*, L., and *I. quinquefolia*, Griseb.—The first two of these creepers have red flowers and are common in the Lautoka and Nadi Districts. They seed profusely and smother the young cane after the manner of Mile-a-minute. The third species *I. quinquefolia* Griseb, has not been notice at Nadi or Sigatoka yet. Its effect on cane is just as bad as that of the others.

Cyperus rotundus, L. (Nut Grass).—This weed in common right through the three Districts and like most *Cyperaceae*, is worst in wet soils. In Hawaii an attempt is being made to reduce it by means of insects and the experiment is being watched with interest.

No mention has been made of the various legumes found in cane fields such as Sensitive Plant, Phaseolus, Crotalaria, &c., as these plants enrich the soil in which they grow and are often sown as cover crops in other tropical countries.

LAU PROVINCE.

One reply in respect of coconut plantations on Kanacea Island was received. Weeds reported are Guava and Seed Grass. The clearing of dense Guava is effected by cutting and stacking for burning at a cost of 9s. to 12s. 6d. per acre. New growth is controlled by slashing and by allowing Kaumoce to form a heavy cover crop. The annual cost of controlling Guava is said to be 2s. to 2s. 6d. per acre. As the island is isolated and privately owned it is not troubled by the appearance of various noxious weeds met with in other parts of the Colony and those weeds that are present are decreasing. Experience has shown that care must be exercised in dealing with Guava. Initial clearing should be done from November to January thus giving the cover crop a full season's growth. It has been found that the growth of an annual cover crop such as Mile-a-minute, Sensitive Grass, or Kaumoce is more rapid than that of Guava. The cover crop is usually left until the following April and appears to stifle successfully the growth of the Guava. The average rainfall on the island is 58 inches per annum.

MACUATA PROVINCE.

One reply was received from Dreketi. The weeds reported are known in coconut plantations and on areas where no cultivation is practised. Guava is regarded as the most serious. The idle lands act as the centres for reinfestation of districts where weeds are kept under reasonably good control.

The informant deals also with the question of uncontrolled animals such as wild pigs and cattle.

Other weeds which cause trouble are Kaumoce, and Blue Rat Tail. Mile-a-minute is found to check the growth of cut Guava but in young coconuts it is itself a source of trouble. Kaumoce and Sensitive Grass are not troublesome weeds in mature coconuts, but need attention on cultivated land. Kaumoce is regarded as a valuable green manure.

NAITASIRI PROVINCE.

Three replies were received. The province is subject to heavy rainfall. Sugar cane is the principal crop, but general cultivation and dairy farming are carried on. Cultivation on arable land reduces considerably the trouble experienced with noxious weeds. In the cane lands, Para Grass, Sensitive Grass, Mile-a-minute and Solanum obtain a hold when land is left fallow, but all are very easily controlled by cultivation. The greater portion of the hill land is not under cultivation and is infested with Koster's Curse, Guava, Mile-a-minute, Solanum and other vigorous weeds which have ousted Para and other grasses of value to dairymen. The hill soils vary considerably, but poor light clay is predominant. Methods of control on areas under cultivation for cane are ploughing and harrowing, but occasional patches of Solanum and Johnson Grass are dug out by hand.

The Colonial Sugar Refining Company Limited, has found that Koster's Curse can be controlled by ploughing and vigorous harrowing, as also can Para Grass. Lantana and Solanum may be partially controlled by cutting back and digging out. Sensitive Grass and Mile-a-minute can only be ckeched by hand weeding, but even then Mile-a-minute often gives considerable trouble in the cane crop, causing fallen stools and low quality cane.

The Methodist Mission at Davuilevu states that on their cultivated land the infestation of weeds is slight. There is heavy growth on uncultivated hills where Koster's Curse, Lantana, Solanum and Guava are met with. Para Grass has been found to check the growth of some weeds but as already observed this plant is itself regarded as a nuisance in certain areas. Stock are run in the Para Grass. Weeds are kept in check on closely cultivated land and in pasture by not permitting stock to eat down Para Grass to such an extent as to encourage the growth of weeds. Noxious weeds are said to be decreasing. Elephant Grass has been found to be keeping out weeds from hill areas. It is said to be easily controlled and is readily eaten by cattle and pigs. If cut down frequently the fresh shoots make excellent green food for poultry. The writer recommends that Elephant Grass should be planted on the hills for keeping down noxious weeds and thus extend the area available for cattle grazing. Solanum is kept in check by school children who are sent out on certain afternoons when the plant is flowering with instructions to slash. It is suggested that school children could with advantage be used more generally for this purpose during certain periods of the year.

In another area where grazing and crop raising are carried on Koster's Curse is the principal weed. Solanum and an unnamed burr occur to a small extent. Sensitive Grass is also met with. For periodical cropping the land is cleared by mowing and ploughing and for the establishment of pastures these operations are followed by the chopping of Para Grass which is disced in during wet weather. Ten acres badly affected with Koster's Curse and Sensitive Grass were cleaned by mowing and ploughing at a cost of £2 5s. per acre. Cutting and grubbing is said to cost more than three times as much. Little trouble is experienced in controlling weeds in arable lands, but to keep them down in pasture lands costs about 10s. per acre per annum. Weeds are said to be spreading in the district. A small root worm has been observed which appears to destroy a good deal of Koster's Curse on hill lands. Weeds are spread by cattle and birds. The methods practised for the control of Koster's Curse are mowing and burning followed by double ploughing and later by systematic grubbing. Solanum is kept in check by grubbing twice annually, Burr by grubbing in the autumn and Sensitive Grass by an annual mowing.

NADROGA PROVINCE.

Two replies were received. Weeds reported are Guava, Solanum, Nut Grass, and Koster's Curse, which are said to be increasing in the district on pasture lands, but diminishing on cultivated lands. Native land is the main breeding land for noxious weeds and general control is impossible on vacant lands even if supervised by a staff of inspectors backed up by the law. It is considered that no other practical methods of control except closer settlement and increased cultivation and greater care of pasture lands will be successful. The overwhelming argument against various methods of control is that there are not sufficient people in Fiji at present to cultivate all the land.

In cultivated land Guava is dug out with Demarara spades and mattocks by contract. Initial clearing costs £3 per acre. Weeds are kept in check on arable land by cultivation and in some pasture land by burning off in dry weather and digging out. Birds, such as Mynahs and Bulbuls spread Guava and Solanum, and cattle eat the Guava fruit and spread the seeds. Flood waters carry the weeds of Solanum and Koster's Curse. The only effective method for controlling Guava is burning-off and digging out stumps. This would appear also to apply to Solanum and Koster's Curse. In the case of Nut Grass a parasite found effective in Queensland has been mentioned but it is doubtful whether it would prove useful as land must be allowed to lie idle for a number of years, although it would be worth while to institute inquiries.

NADI PROVINCE.

One reply received. Sensitive Grass has been found troublesome in pine-apple land. Disc ploughing is utilised for initial clearing and the land is kept free from weeds by intense cultivation. Experience in cane growing in Queensland is said to have shown that the best method of controlling Sensitive Grass is by cultivation and spraying with a solution of arsenite of soda. The uncontrolled grazing of stock appears to be the principal means of spreading weeds and it is recommended that graziers should be compelled to keep their lands free from noxious weeds. Vacant lands owned by absentees form breeding grounds for weeds which spread rapidly and control by resident cultivators is rendered considerably more difficult.

SERUA PROVINCE.

One reply received. Large areas of unoccupied European land are covered by a dense growth of Koster's Curse and some land which is nominally occupied is infested with noxious weeds, particularly Koster's Curse, the seeds of which are spread by the mongoose and birds. The cost of clearing noxious weeds is much heavier near the boundaries of areas used for pasture purposes than on those paddocks which are more distant from the centres of infestation. Koster's Curse appears to be the most serious weed encountered and so long as large areas remain without any attempt to control the weeds, the task of those who are endeavouring to keep their land clear will be rendered difficult and expensive.

REWA PROVINCE.

One reply received. Weeds encountered on pasture land are Koster's Curse, Solanum and Lantana, which are sparse on account of the control exercised. Principal crops grown are sugar and rice and a little maize. The weeds are kept down by constant cultivation. Initial clearing of noxious weeds varies from 30s. to 53s. per acre according to the density of the growth. In arable lands weeds are kept under control by cultivation and in pasture land by constant cutting and rooting out. Unused areas are left until required as the cost of control of weeds is too excessive to do otherwise.

Control of weeds in pasture lands costs £1 per acre per annum. Solanum is said to be increasing rapidly. Koster's Curse and Lantana apparently are stationary. Heavy growth of Mile-a-minute has been observed to check the spread of Koster's Curse, but appears to have no effect on Solanum or Lantana. Birds cause re-infestation of cleared lands rapidly. Pasture land once thoroughly cleared of weeds can be kept practically clear from them by one man to every 50 acres.

RA PROVINCE.

The following extract is taken from the one reply received from the Manager of the Colonial Sugar Refining Company Limited, Penang:—

The area held by us here is about 18,000 acres of which about 4,500 acres are, or will be cultivated for cane, and the balance is hill land of which perhaps half could be used for grazing. The main crop is cane, though small areas are devoted to rice and maize.

The only noxious weeds of importance here are Ellington Curse and Guava and neither of these give any trouble on the cultivated areas. Koster's Curse and Solanum I. have not seen in the district. A couple of years ago there was a small amount of Noogoora Burr, but this has been destroyed and is not now in evidence.

Ellington Curse is fairly dense on some of the steeper and stonier hills at Ellington but outside that area it is sparse to negligible.

Ellington Curse seems to prefer good soil but grows equally well on stony hills and on the sandy soil of the sea shore just above tide reach.

Guava is dense on some of the hills nearer Penang. It prefers good soil and its growth is of small account on the distinctly poorer soils.

The only method which seems to avail against Ellington Curse or Guava is to grub it out, roots and all.

We have done no clearing of either growth ourselves and cannot compare the probable cost. Considerable areas have been cleared by our tenants, however, and they invariably cut down the bushes and grub out the roots with mattocks. There is no sign of either weed returning on the cultivated land.

In my opinion Guava is a much greater nuisance than Ellington Curse because birds and cattle carry the seed which is quickly re-sown on cleared land; but neither birds nor cattle appear to touch the seeds of Ellington Curse so that the growth can only spread slowly around the parent plant.

Ellington Curse, however, has large thorns which are to a certain extent poisonous and on this account it is a bad weed to have in cattle country.

COLO NORTH PROVINCE.

One reply received, in respect of grazing land. Guava is the principal serious weed met with. Effective clearing has been done by cutting above the ground when the sap is down and poisoning with a solution of arsenite of soda applied to the freshly cut stump with a paint brush. The cost of clearing and cultivating land heavily infested with Guava is £3 10s. per acre. Ellington Curse is also met with and is kept under control by constant grubbing. Guava is said to be increasing alarmingly throughout the whole district. The ripe fruit is eaten by horses, cattle, pigs and a number of birds, and the seeds are spread by the droppings. Young plants are observed coming up freely in the wet season and apparently have no natural enemies. The main solution in regard to Guava seems to be the prevention of fruiting. Ellington Curse is confined to the coastal areas and its spread is much more gradual. Solanum and Lantana are found in the mountain area and along the water ways. Seeds of Solanum are spread by birds. The spread of Guava on grazing land is regarded as a serious economic problem. It is suggested that Government should let grazing land on a longer lease and make the control of noxious weeds a condition of the lease. Short leases and high rentals are regarded as a contributing factor to the invasion of weeds. The writer states that in his view there are some one and a half million acres of grazing land within sixteen miles of the coast between Vitilevu Bay and Sigatoka and that of this one quarter is infested with Guava. The possibilities of biological control should be explored. Fijians should be debarred from giving yearly terms for the occupation of land to any person for the purpose of grazing, as in such cases occupants move at the end of two or three years and leave the land infested with weeds which gradually infest the surrounding areas.

TAILEVU PROVINCE.

Ten replies were received. The principal weeds are Guava, Koster's Curse, Solanum, Burr, Kaumoce and Blue Rat Tail. Koster's Curse has

obtained a firm hold in the district and may be observed growing luxuriantly on large areas. Hand clearing, followed by burning, ploughing and harrowing is used to clear land of noxious weeds, for the establishment of pastures. Direct ploughing by a tractor and disc plough has recently been practised, but it is early to state whether this is an effective method unless followed by further clearing of secondary growth. Noxious weeds in the pastures of the dairy farms are a constant source of trouble and expense to the dairymen. The annual cost of maintaining pastures reasonably free from weeds ranges from about 7s. 6d. to £1 per acre per annum. Initial clearing of noxious weeds costs from 30s. to £3 per acre, according to the degree of infestation and the nature of the weeds. Koster's Curse is kept under partial control in pasture by cutting out with knives, pulling out the roots or grubbing with a mattock. It is suggested that a grass of good quality that will cover the ground in a close mat will assist considerably in controlling weeds. Sensitive Plant it is said by some dairy farmers to check very considerably the growth of Koster's Curse. The application of manures to pastures at the proper time encourages the growth of grasses at a greater rate than that of weeds and helps to keep the latter under control. Birds and the mongoose are the principal agents that cause the spread of noxious weeds. One writer states that steps should be taken to exterminate wild pigeons and that in any case they should be no longer protected.

A letter dealing in general terms with this subject was received from one of the Firms who control large interests in the Colony, pointing out that the great danger from noxious weeds in the majority of cases lies in the unused or partly used native land. This increases the difficulty of the problem enormously because even if Government took steps by statute to enforce their labour the available Fijian population is not large enough to deal with periodical weeding of their land and moreover, the value of the great portion of that land is so low as to make it impossible to recoup the cost of controlling the weeds growing on it. The problem is, however, complicated by the continued fall in the market value of copra, which has rendered it necessary to reduce plantation costs to the lowest possible limit with the result that periodical weeding has been one of the first services to be sacrificed.

SUMMARY.

A survey of the question of noxious weeds in Fiji indicates that there are some five aspects of the problem. These are:—

Weeds in—

(*a*) cultivated land;
(*b*) grazing areas;
(*c*) dairy farms;
(*d*) coconut plantations;
(*e*) unoccupied native and other land.

The control of noxious weeds in arable land is not a serious problem, although the annual cost is increased because of the large areas infested with weeds contiguous thereto. In grazing land where large areas are stocked with cattle at the rate of one beast to several acres, weeds are increasing and the available grass land is being reduced at a rapid rate by the spread of Guava and other objectionable plants. The control of weeds in such areas is undoubtedly a very difficult problem and the constant cutting and grubbing which can be practised in dairy farming areas where intensive grazing is carried on are impracticable in other grazing areas.

In the dairying areas it appears possible without great difficulty to keep pasture land reasonably free from weeds by constant attention, but the cost

of this work is a heavy charge on the dairy farmer and difficulties are again increased by adjacent heavily infested areas which re-infest the pasture lands rapidly.

In well-run coconut plantations periodical weeding is normally practised, but there can be no doubt that the fall in the value of copra will lead to a considerable curtailment of the expenditure for upkeep and maintenance of plantations, and weeds may rapidly obtain a firm hold in areas which have for many years been reasonably clear.

Vacant lands, many of which have at some time or other been under cultivation, are a constant menace to every phase of agriculture in the Colony. As has been seen the fruits of many of the weeds are eaten by birds, mongoose and other animals and spread by their excrements. Though there seems little hope of justifying the enormous cost of clearing these vacant lands of weeds or even of keeping the heavy growth under reasonable control, it would appear advisable to limit as far as possible the agencies which distribute the seeds.

From the information available it appears that Guava may be regarded as the most serious weed in Fiji. It is spread easily, grows rapidly and if unchecked develops into a sturdy tree which is costly to cut out, although the wood is a valuable fuel and makes excellent charcoal. Koster's Curse grows luxuriantly and spreads rapidly but appears not to deplete the soil of plant food to an undue extent. It can be dealt with without great difficulty on land which it is desired to bring under cultivation, but is a more difficult problem in dairy lands where it springs up rapidly if care is not constantly exercised.

Lantana in several districts is being kept under control biologically by the insects imported from Hawaii and the more general distribution of these insects as colonies become available will undoubtedly contribute to the destruction of this weed. Prickly Solanum appears to be increasing in many districts. It is of sturdy and luxuriant growth and fruits heavily. Although cattle occasionally eat it when more attractive fodder is not available they cannot be said to keep it under any degree of control. Blue Rat Tail is a nuisance wherever found and simple cutting is useless in endeavouring to control it. It must be uprooted completely if it is desired to eradicate it from any area.

It appears impossible to institute one method for the complete control of the more important noxious weeds of the Colony. Methods must be adapted to the principal needs of the various agricultural pursuits, and for this reason it is hardly necessary to consider the problem of arable lands where constant cultivation is necessarily practised in connection with the growing of crops. It will therefore be convenient to consider land which falls into the three catagories—

(*a*) dairy land;
(*b*) land under permanent crops, *e.g.*, coconuts;
(*c*) vacant land.

Apart from the methods already briefly discussed there appear to be three possibilities—

(1) biological control;
(2) destruction of plants by spraying;
(3) the use of beneficial cover crops, or permanent crops which will repay the cost of their planting during the early stages of growth.

In connection with (3), the matter of afforestation arises.

(*To be continued.*)

COPRA DRIERS—REPORT OF VISIT TO WESTERN SAMOA.

By A. C. Barnes, F.I.C., B.Sc., A.M.I.Ch.E.

INTRODUCTION.

The primary object of my visit to Western Samoa was to examine the types of copra drier in use on the New Zealand Reparation Estates. The opportunity was taken of visiting other plantations where artificial driers were in use, and of investigating to some extent the manner in which the copra industry was conducted on the Estates. In addition, inquiries were made into the present position and prospects of the banana industry, a subject which has been reported upon separately.

2. I received every possible assistance from Officers of the Government of Western Samoa, and of the Reparation Estates, and was afforded opportunities for making as complete an investigation as was permitted by the limited time available. The Manager of the Estates accompanied me on visits to the plantations under his charge on four days, and supplemented the observations I was thus able to make by supplying detailed information and plans from his records.

PLANTATIONS VISITED.

3. The Reparation Estates consist of a number of plantations, of which I visited three, Vaitele, Vailele, and Mulifanua. A drier belonging to Mr. Mauritz, and a small village drier erected by the Government for native use were also inspected. Visits were made to the estates of Mr. Brighouse and Mr. Cobcroft, on both of which driers were in operation.

THE COPRA INDUSTRY ON THE REPARATION ESTATES.

4. Before proceeding to describe in detail the various types of copra driers examined, it may be well to deal briefly with the general manner in which the production of copra is carried out on the Estates.

5. The coconut plantations are well laid out and the trees have been regularly planted, 30 ft. by 30 ft. square. The soil is volcanic and rocky, volcanic stones being in evidence on most of the areas, so that mechanical cultivation is impossible and hand weeding difficult. Ground cover consists mainly of sensitive plant (*Mimosa pudica*) and cattle are run on all plantations. They successfully keep down the growth and form a valuable source of revenue. The plantations carry about one animal per acre.

6. A recent muster gave returns as follows:—

Plantation.	*Area.*	*Stock.*
Vaitele	1,473 acres	1,660 cattle.
		40 working bullocks.
		45 donkeys.
Mulifanua	4,200 acres	4,277 cattle.

7. The plantations are well fenced and subdivisions are further divided into grazing areas of convenient size. Iron spiral fencing posts are being used to an increasing extent. They are cheap, of light weight and strong. The cost *ex* New Zealand landed in Samoa is 1s. 6½d. per post, but I am informed that they can be imported direct from England to Fiji at a landed cost of 1s. 2½d.

8. Good roads exist on all the plantations and greatly facilitate the work of nut collection, general transport and communication. Though

bullock carts are largely used at present, some motor trucks are employed, and it is understood that motor vehicles will be used to an increasing extent in the future.

9. The Estates are divided into units of convenient size for ease of working, and an artificial drier is located in each subdivision. The collection of nuts is carried on by groups of coolies who work systematically through the area in such a manner that a complete cycle occupies about six weeks. Donkeys with pannier baskets are used to carry the nuts to the roads, where they are dumped, loaded into bullock waggons and thus carried to the cutting station situated near the drier. Here the nuts are placed under shelter in readiness for the cutters, who are divided into two groups, one of which spilts the nuts while the other cuts out the copra and places it into boxes for transference to the drier. The floor of the portion in which the nuts are split open is covered with sections of coconut tree trunks lying transversely and in this manner the nuts are conveniently chopped open by an axe while the " milk " runs down between the logs into a drain.

10. The daily tasks for these operations are as follow:—

	Nuts per man per day.
Collecting	1,200
Chopping	4,000/4,300
Cutting out copra	600 lb (net)

11. The green copra is transferred to the drier with a minimum of delay and there can be no doubt that this contributes largely to the high standard of quality of the product.

TYPES OF COPRA DRIERS.

12. On the Reparation Estates two main types of driers are in operation and may be referred to respectively as the German Drier and the Chula. Different examples of each of these types are in use and will be described separately.

13. The German driers are essentially of the hot air type with natural draught. They consist of a masonry chamber over which is constructed the drier proper which includes a drying chamber and a loading and discharging platform. The driers vary in size and capacity and although there are several of them no two are alike. It is evident that when they were constructed certain variations were resorted to, possibly with the object of determining the best design for final adoption.

14. At one end of the masonry chamber below ground level, is a fire-box with an extended combustion section, from which a rising pipe leads to the air heating pipes and thence to the chimney, which is erected outside the building. The air heating pipes are arranged at different levels, and are so constructed that their ends are set in the walls of the chamber and can be opened for cleaning. Connection between successive pipes (or flues) is made by short transverse sections of the same diameter of pipe.

15. At ground level, the chamber is pierced by a number of apertures which are capable of being opened and closed at will, thus allowing ingress of cold air which is subsequently heated by the pipes and rises into the drying chamber, finally passing out through a ventilator or ventilators in the roof.

16. Firing is affected by coconut husks with attached shells. Practice has shown that the fuel from a given quantity of nuts is more than sufficient to dry the copra from these nuts. The design is shown in the diagram.

Detailed plans were furnished by the Manager of the Reparation Estates, and may be consulted at the offices of the Agricultural Department. It will be convenient for this purpose of the report to describe a two-compartment drier.

17. The fire-well is 6 ft. deep and furnace 4 ft. 6 in. long to the face of the sloping fire brick end, with an ash-pit 18 in. deep below the fire bars. A 12 in. aperture above the fire brick face leads into an extended combustion chamber, which has a cleaning well at the far end. From this a rising pipe about 18 in. in diameter leads to a level heating pipe within the masonry chamber and to a further inclined pipe passing in the opposite direction which joins the chimney.

18. Usually the air heating pipes are fixed longitudinally under the drying compartments, one pipe running underneath each compartment. In one instance, however, these pipes are set transversely, and it is stated that this particular drier gives better results than the others.

19. The masonry chamber is 7 ft. 6 in. high, 7 ft. 6 in. wide and 15 ft. 9 in. long. The centre line of the inclined heating pipe is 3 ft. 9 in. above ground level at one end, and 4 ft. 3 in. at the other. The bottom of the drying chamber is open. The necessary structural rigidity is secured by a heavy rail, laid longitudinally, carrying the centre wall of the two compartments.

20. Each compartment measures 3 ft. 1 in. from wall to wall and is 9 ft. 6 in. high and 16 ft. 3 in. long. Hardwood runners for 18 tiers of trays in each compartment are fitted to the wooden walls which are hollow and filled with sand to secure heat insulation. The trays themselves are 3 ft. by 2 ft. with wooden frames covered with half-inch square mesh wire. On the bottom, hardwood strips are nailed over the wire mesh to facilitate the movement of the trays within the drier. The substitution of hardwood runners on the walls of the drying chamber with angle iron has been found effective in facilitating working and reducing wear.

21. It will thus be seen that each compartment is capable of carrying 144 trays if completely filled, but in practice the lowest trays are covered with fine mesh netting in order to catch small particles of copra and dust which might otherwise fall on the heated pipes and add to the risk of fire. The first two or three runners are generally left devoid of trays. During the course of the drying the position of the trays is changed from time to time. A long pole with a hook on the end is used to pull the trays from the far end of the drying chamber.

23. The chambers are closed completely at one end, doors being placed at the other, where the handling, changing and discharging takes place entirely. The design would be improved by fitting doors at both ends, but in this case the building in which the drier is housed would need to be extended. In the middle of the roof of the drying chamber is situated a transverse ventilator 6 ft. 8 in. long by 2 ft. wide and 7 ft. high.

24. The drying chamber is housed inside the building which is floored at both sides and one end. The floor of this is 7 ft. 6 in. above ground level and access to it is afforded by steps. It will thus be seen that the disadvantage of the drier is that the floor of the loading platform is considerably above ground level and the green copra and the dried copra have to be carried up and down respectively. To construct this type of drier in such a manner that the loading platform is at ground level would involve costly excavation.

25. The space on each side of the drying chamber is utilised for bagging the discharged dry copra without interfering with the normal working of the drier. The capacities of driers of this type are as follows:—

Two-compartment	..	2,500/3,000 lb green copra.
Three-compartment	..	4,000/4,500 ,,
Four-compartment	..	5,000/6,000 ,,

26. The time required for drying is 30–36 hours. The product is clean, white and apparently of excellent quality. The results of analyses of samples taken from these driers are given in the Appendix.

27. The estimated cost of erection of a three-compartment drier is £550, and the cost of drying, including all charges is £1 0s. 5d. per ton. This is worked out as follows:—

Depreciation buildings, 5 per cent...	£27	10	0
Repairs, &c. (estimated)	20	0	0
Flue pipes, furnace, smoke-stack and renewals (Total £60 cost for 3 years) ..	20	0	0
Labour—1 night and 1 day boy	94	0	0
Repat. and Rec. charges	15	0	0
Renewal trays and runners	10	0	0
Interest—6 per cent. on capital	33	0	0
Overhead plantation based on ⅓ labour cost ..	31	0	0
	250	10	0
Kerosene (lights)	5	0	0
Annual cost	£255	10	0

Four dryings a week—270 tons p.a.; allow 1 month p.a. for repairs—250 tons=£1 0s. 5d. per ton for maximum drying.

NEW TYPE OF HOT AIR DRIER.

28. An interesting drier of somewhat unusual construction has been erected by Mr. Mauritz for drying green copra purchased from natives. This again is a hot air drier, the heating being effected by a furnace with flue or flues passing through a longitudinal air mixing chamber. Above this chamber on one side, the drying chamber is constructed consisting of a large sloping wooden box, divided into compartments. Hot air from the air mixing chamber is admitted through a vent at the lower end of each compartment and rising through the compartment emerges through a ventilator door which can be adjusted to control the rate of passage of air as well as the rate of drying. The drier that I examined had eight compartments each of which was 3 ft. wide, 8 ft. long and about 3 ft. in height. Five angle iron runners were fitted on each side of the compartment and small trays about 3 ft. by 2 ft. covered with wire mesh were used to hold the copra. The drying chamber is set at a slope of 12½ deg. and charging and discharging is effected at the upper end, the more distant trays being moved by means of a pole with a hook at the end as already described. The capacity of the drier is 2,500 lb of green copra, equivalent approximately to 1,500 lb of dry. The period required to dry is about 24 hours. I was very much struck with this drier, which is of very simple construction and can be so built that charging and discharging takes place at a convenient height above ground level. The supply of hot air to each compartment can be regulated both by the door at the upper end as well as by slides over the hot air ducts at the lower end. Deflecting places are fitted at the lower

end in order to ensure an adequate supply of hot air to the lower trays. It would be possible to construct such a drier with two wings set over the same mixing chamber with adequate heating by one furnace. I was unable to ascertain the cost of construction, but consider that it would not be more than two-thirds of that required for a three-compartment German type of drier having a similar capacity. The drying chamber is lined in each compartment with compressed megasse, a material which possesses heat insulation properties, and which is cheap and convenient to use for such a purpose. Hot air circulation is secured by natural draught only and no mechanical appliance of any kind is necessary for the operation of the drier. The slope of the drying compartments adds somewhat to the labour of discharging the dried copra, but as the trays are light and carry only a few pounds of copra each, this is not a serious disadvantage. (see diagram).

HOT WATER DRIERS.

29. Several hot water driers were installed by the Germans on various plantations in Samoa. The essential difference between them and the hot air drier described in the first instance is that the heating of the air for drying is effected by a system of hot water pipes placed underneath the drying compartments and connected to a water heater at the side. In practice it has been found that these give very satisfactory service. The cost of upkeep is low and temperature control is more readily effected than with the ordinary hot air type. I was unable to ascertain the cost of erection of a drier of given size operated by hot water. Particulars of a small one installed by the Samoan Government for village use are given in the Appendix.

TUNNEL DRIER.

30. Mr. Mauritz also has a tunnel drier with hot air circulation effected by a power driven fan. So far as I could gather this drier gives excellent service, but it appears to me to be unsuitable for general adoption in view of the cost of construction and the fact that it requires power and therefore some skilled mechanical attention to operate it.

31. It was interesting to observe that Mr. Mauritz had installed the new sloping drier over the same air heating and mixing chamber as is used for the tunnel drier, and that he used the new drier in preference to the old one,

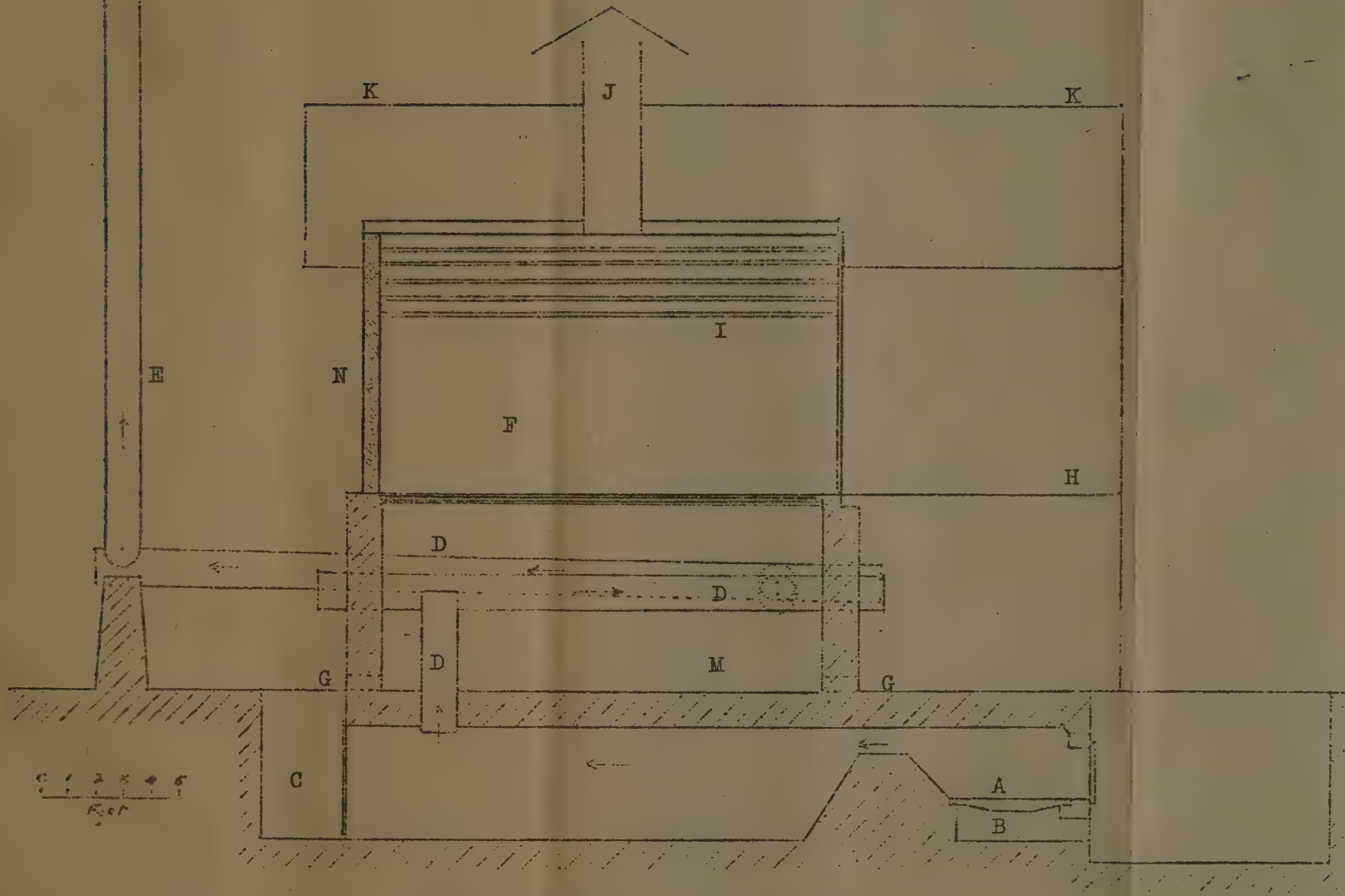
GORDON DRIER.

32. I had the opportunity of inspecting a Gordon Drier used in cocoa drying on the Estate of Mr. Cobcroft. As, however, this machine was not of particular interest from the point of view of copra drying, it is not necessary to describe it.

CHULA DRIERS.

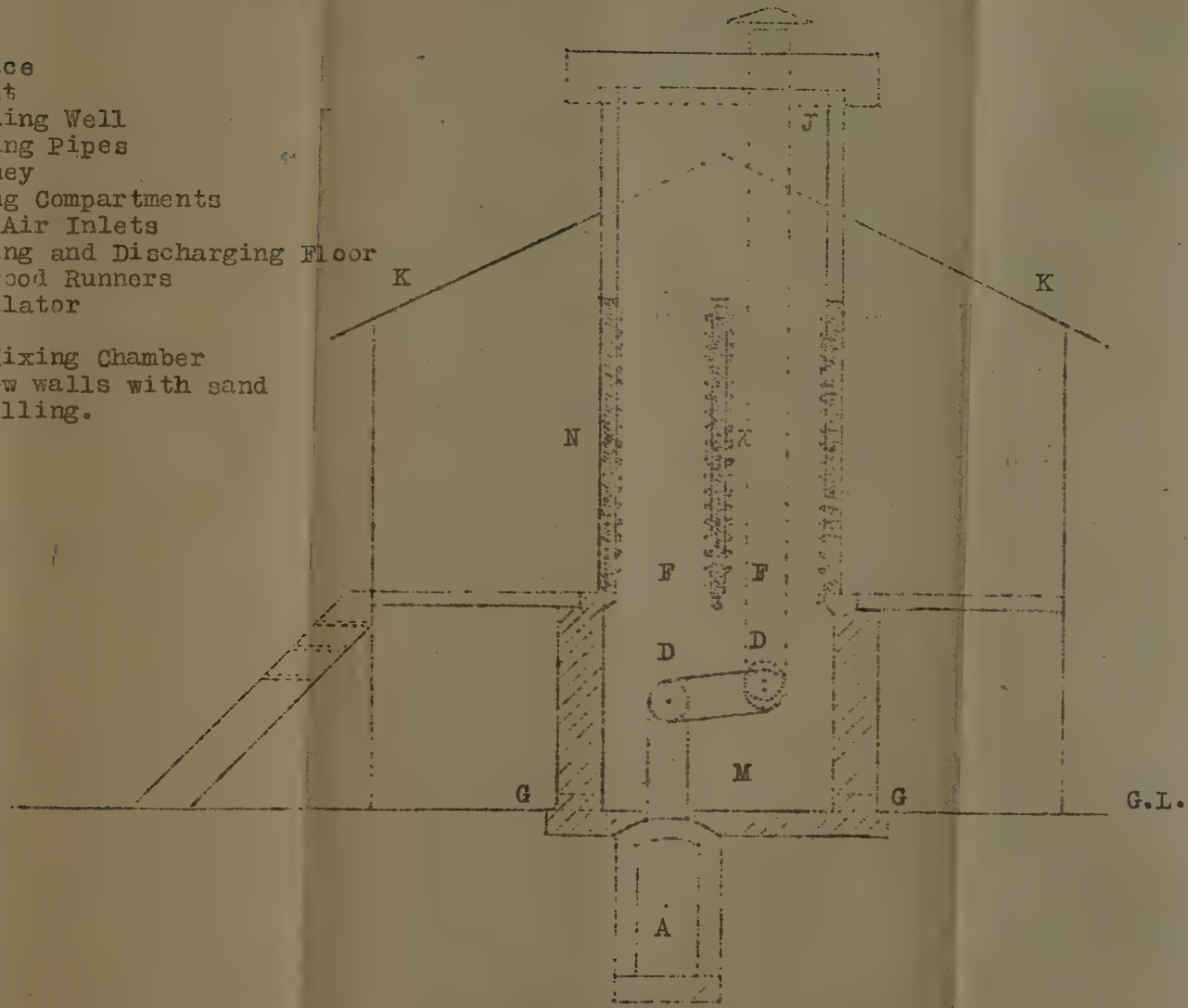
33. Two different types are in use on the Reparation Estates. A mechanically operated air circulation fan is common to both, except that the power used is different in each case. The Chula drier at Vailele is a so-called one-way drier; that is, the hot air circulates only in one direction and no means of reversing the air current are available. The copra is dried in bulk, and in practice it has been found that the material with which the hot air first comes in contact is dried comparatively rapidly, while that through which the air finally passes still has too high a content of moisture when the other is dry.

34. To overcome this difficulty a longitudinal partition has been put in the drying chamber so as to divide it into two equal parts. The system of working is such that the dried copra from the lower compartment is



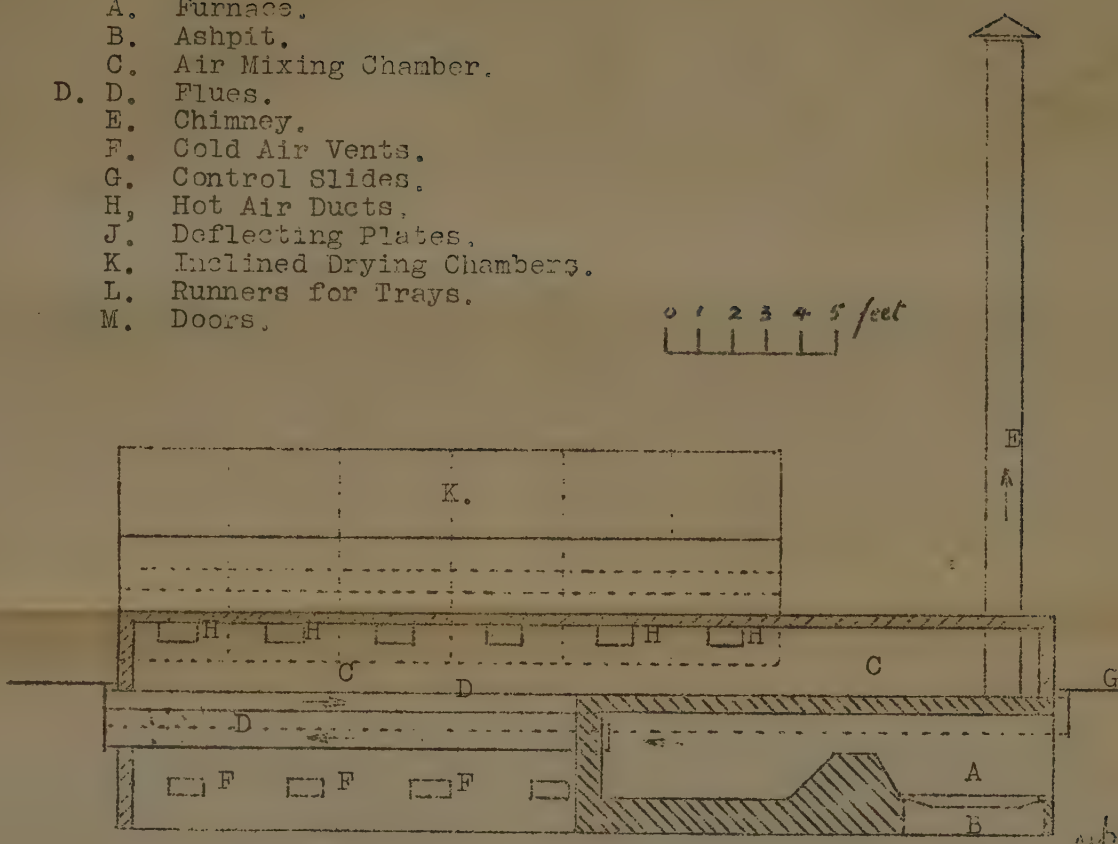
TWO COMPARTMENT HOT AIR COPRA DRIER
SIDE VIEW
Part Section
(Constructional details not shown).

A. Furnace
B. Ashpit
C. Cleaning Well
D. Heating Pipes
E. Chimney
F. Drying Compartments
G. Cold Air Inlets
H. Loading and Discharging Floor
I. Hardwood Runners
J. Ventilator
K. Roof
M. Air Mixing Chamber
N. Hollow walls with sand filling.



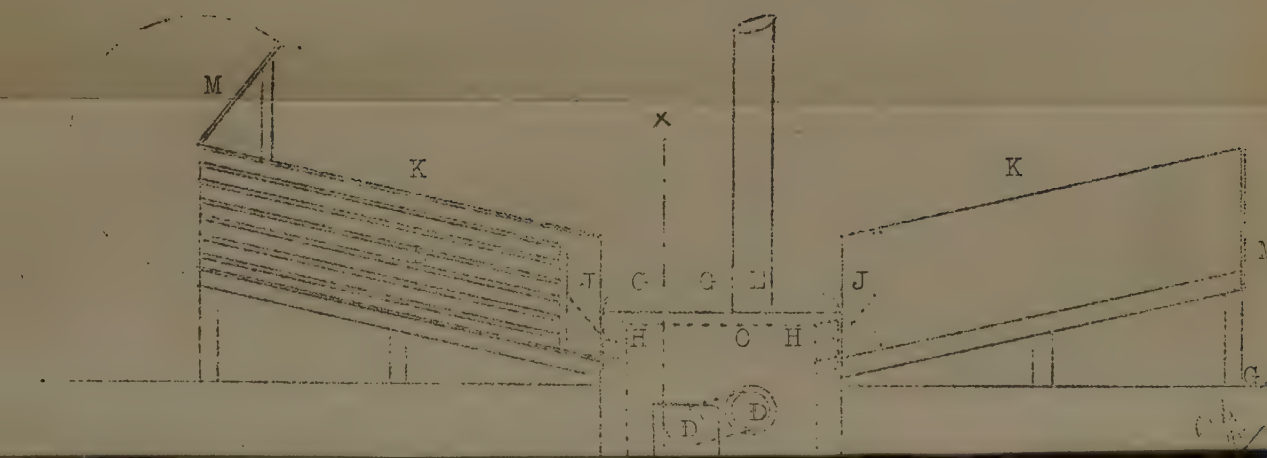
TWO COMPARTMENT HOT AIR COPRA DRIER
END VIEW
Part Section

A. Furnace.
B. Ashpit.
C. Air Mixing Chamber.
D. D. Flues.
E. Chimney.
F. Cold Air Vents.
G. Control Slides.
H, Hot Air Ducts.
J. Deflecting Plates.
K. Inclined Drying Chambers.
L. Runners for Trays.
M. Doors.



INCLINED CHAMBER COPRA DRIER.

Section through X.Y.



discharged when ready and that from the upper is allowed to pass into the lower one, the upper one being again charged with green copra. In comparison with the other types of driers in use on the plantations, the Chula is very uneconomical. Drying costs are considerably increased by the necessity for skilled attention to the engine which drives the fan, and it is found that the rate of depreciation is high and repairs cost an excessive amount. The furnace, which is an essential part of the drier, appears to burn out fairly rapidly and to reduce costs of repairs and renewals a separate furnace has, in one case, been built.

35. At Mulifanua, there is a two-way Chula drier in which a more even drying of the copra is effected by reversing the hot air current by means of a slide operated above the drier. In this case a steam engine is used to drive the fan, whereas at Vailele an internal combustion engine is employed.

36. The capacity of the one-way drier is 2,500/3,000 lb of green copra and of the two-way drier 5,000/6,000 lb. Both machines take from 36/40 hours to dry one charge. Roughly, the cost of erection of a two-layer one-way drier of the stated capacity, with engine, is £800. The estimated cost of the necessary building in which to house it is £100. Details of the cost of drying are set out in the Appendix.

GENERAL REVIEW OF METHODS OF DRYING IN SAMOA.

37. Summarising the results of my observations which are supported by some knowledge of types of driers in use in other places, I put the driers described in the following relative order of preference, taking into account efficiency, ease of working, initial cost of erection, upkeep, depreciation and repairs and suitability for conditions in Fiji:—

(1) The inclined chamber drier.
(2) German type direct air heated drier.
(3) German type hot water air heated drier.
(4) Chula two-way drier.
(5) Chula one-way drier.

38. In my view the inclined chamber drier represents a very considerable advance on anything I have yet seen of its capacity, though I am of opinion that a number of improvements could, with advantage, be effected.

GENERAL ECONOMICS OF THE PRODUCTION OF COPRA ON THE REPARATION ESTATES, WESTERN SAMOA.

39. *Yield per acre.*—As elsewhere, there is a considerable variation in the yield per acre per annum of copra on the Estates in Samoa. Records kept over the past six or seven years show that the yield ranges from 537 lb to 1,056 lb. The table below gives the highest and lowest figures recorded during that period on three of the Estates:—

	Highest.	*Lowest.*
Mulifanua	1,857 lb per acre	1,686 lb per acre.
Vaitele	1,056 ,,	626 ,,
Vailele	793 ,,	537 ,,

40. *Costs of production.*—The average number of units of labour required to produce one ton of dry copra was 40 in 1929. This includes labour for the cattle, which are run as an integral part of the plantation working.

41. The cost of copra at Apia is given as £9 9s. 4d. per ton f.o.b.—according to the detailed statement in the Appendix. Transport to Apia, insurance and the cost of bags and twine have been included. It should be

observed that the figures given include charges in respect of the stock industry and that the profits on sales of cattle have been deducted from the total cost thus arrived at.

41. *Marketing.*—Copra produced on the Reparation Estates is marketed in London, Hull and Hamburg. Freight costs £3 7s. 6d. per ton weight. Recent market quotations are:—

Date.	*Plantation.*	*Crown Estates.*
23/11/29	£21 10 0	£22 10 0
4/1/30	21 12 6	22 10 0
1/2/30	21 12 6	22 15 0
5/4/30	20 15 0	21 5 0
5/5/30	21 0 0	21 12 6
14/6/30	18 5 0	19 0 0

APPENDIX.

RESULTS OF ANALYSES OF SAMOAN COPRA.

Sample	Moisture in vacuum oven at 100°C.	Oil on moisture free copra.	Oil on original copra.	Free fatty acid (Lauric).
1. Vaitele, Mauga Station ..	7·76	67·53	62·29	0·30
2. Vaitele, Vaitele Station, drying completed 15/5/30, sampled 26/5/30	6·07	67·68	63·57	0·39
3. Mr. Mauritz	6·73	65·45	61·05	0·64
4. Vaitele, Suga Station, Chula, 26/5/30	7·54	69·50	64·26	0·27

The samples were in splendid condition and showed little sign of mould action. Samples Nos. 1 and 2, plantation copra, dried in German hot air driers. Sample No. 3, native copra, dried in inclined chamber drier. Sample No. 4, plantation copra, dried in one-way Chula drier. It should be observed that the moisture content has been determined in a vacuum oven which gives more accurate results then are obtained by the usual stem oven method when vegetable oil bearing materials are being examined. The figures may appear to be higher than normal in consequence. The analyses were performed by Mr. W. J. Blackie, M.Sc., Government Chemist.

PARTICULARS OF HOT WATER DRIER ERECTED AT VAIUSU VILLAGE.

Drying Chambers (3) ..	2 ft. 6 in. (approx.) by 5 ft. by 6 ft. high.
Runners	5 in. centres (approx.). (14 sets to each compartment).
Trays	28 per compartment.
Ventilator	5 ft. by 2 ft. (with control).
Heating pipes	128 feet of 2½ in. bore pipes with radiating fins, in two banks.

CHULA ONE-WAY.

Capital cost erected £800 with engine, building necessary estimated at £100.

ANNUAL CHARGES.

Depreciation, Chula 10 per cent., engine 10 per cent. ..	£80 0 0
Building, 5 per cent.	5 0 0
Pipes, furnace, smoke stack renewals	15 0 0
Engine boy, day and night, at £6 per month each .. One boy for filling, &c. (Samoan)	200 0 0
Fuel, oil and repairs to engine	180 0 0
Interest on capital, 6 per cent.	54 0 0
Overhead at same basis as German	31 0 0
Kerosene..	5 0 0
	£570 0 0

Capacity, 2,500 lb wet; annual output, 125 tons; cost per ton, £4 11s. 2d.

CHULA TWO-WAY.

Cost Chula, £971 4s. 10d.; boiler, £348; total, £1,300.

ANNUAL CHARGES.

Depreciation buildings, 5 per cent.	£5	0	0
Chula and engine, 10 per cent.	130	0	0
Pipes, furnace, smoke stack renewals	25	0	0
Labour as one-way	200	0	0
Repairs engine, pulleys, shafting, belting, &c.	30	0	0
Lubricating oil	20	0	0
Interest on capital	78	0	0
Overhead on same basis	31	0	0
Kerosene	5	0	0
	£524	0	0

Capacity, 5,000 lb wet; time of drying, 36 to 40 hours; Annual output, 250 tons; cost per ton, £2 1s. 11d.

COST TON COPRA LANDED IN APIA YARD.

Vaitele; 476 tons; April 1st to March 31st, 1929–30.

Labour direct.	*Cost.*		
Beetle searching	0	8	4
Weeding	1	3	4
Donkey boys	0	18	5
Transport—Bullock waggons, &c.	0	11	4
Choppers—One boy to six choppers	0	4	10
Cutters (average, 518 lb	1	6	0
Drier boys	0	13	1
Bagging and loading	0	1	9
Cattle, mustering, branding, killing, &c.; water-supply, fencing, roading, horses, breaking donkeys and bullocks, messengers, motor lorry drivers, paddocks, servants	1	15	1
	£7	2	2
Stores, being supplies of tools, fencing material, timber, petrol, and all necessary materials for use on plantations	0	13	5
Apia charges, rates, taxes, telephones, drier repairs, repairs to motor lorries and other direct charges from Head Office	0	19	9
Management—Salaries of Manager and assistants	2	4	0
Depreciation—Overhead, &c., building, plant and machinery, vehicle, harness and saddlery, motor lorries, furniture and fittings, &c., head office overhead charges, stationery, &c., &c.	1	7	0
Total	12	6	4
Less profit on cattle	2	17	0
	£9	9	4

RHINOCEROS BEETLE—POSSIBILITY OF ACCIDENTAL IMPORTATION FROM SAMOA.

By T. H. C. TAYLOR, B.Sc.

THE Rhinoceros Beetle (*Oryctes rhinoceros*, Linn) is widely distributed in the Tropics. It is a well known pest of coconuts in India, Ceylon, Malaya, the East Indies and the Philippines and many other countries.

2. The beetle appears to have been imported into Samoa in or about 1910 from Ceylon in boxes containing rubber stumps packed in soil and vegetable refuse. It soon became a pest of major importance in Samoa and has done much more damage there than in the Far East, where it is indigenous, presumably owing to the absence in Samoa of its natural enemies.

3. On account of the close proximity of Fiji and Samoa and of the direct shipping communication between them, there is a risk of the beetle being introduced into Fiji. This risk was first appreciated in 1912, when

F. P. Jepson, Government Entomologist in Fiji, visited Samoa to investigate the matter and published a report thereon (Department of Agriculture, Fiji, *Bulletin* No. 3). This report, together with others which have since been published elsewhere (notably in the Philippines) constituted a fairly complete account of the various stages and habits of the pest, a thorough knowledge of which is essential if the insect is to be kept out of Fiji.

4. Twenty years have elapsed since the Beetle first reached Samoa and it has not yet become established in Fiji, so the risk cannot be very great. Nevertheless, the risk is always present and it is doubtful whether the Regulations concerning ships arriving at Suva from Samoa have been sufficiently strict in the past to eliminate it completely. The absence of the beetle in Fiji is probably due more to good luck than good management.

5. The work of Jepson in Samoa and of Mackie in the Philippines shows that the beetles lay their eggs in rotting vegetable matter, chiefly in dead coconut trunks and stumps and in heaps of coconut leaves and husks. The egg stage covers about 12 days. The resulting grubs feed entirely upon dead vegetable matter of this nature and never attack healthy coconut palms. The duration of the larval stage is long, roughly five to six months. The subsequent pupal stage occupies five to six weeks. The life cycle, from egg to adult, therefore occupies about seven months. The damage to the coconut palms is due only to the adult beetles, not to the larvæ. The beetle are entirely nocturnal in their habits and are frequently attracted at night to lights in houses and on ships in port. (I have seen many beetles of a closely allied species at night in an hotel near the wharf at Samarai, New Guinea, and also occasionally in hotels in Java and Malaya.) The beetle feeds by boring into the head of a coconut palm, often cutting off the tops of young unopened leaves in the central shoot or "cabbage," and sometimes killing the tree outright. It never attacks opened leaves. On account of its large size, a single beetle can do a great deal of damage. The adult insect feeds not only upon coconuts but also on may other species of palms and it has even been reported to attack sugar cane. It probably lives for several weeks when an abundant food supply is available, and would certainly survive for several days without food.

6. It is clear that the insect might be brought to Fiji in the egg, larval, or pupal stage in vegetable matter, and it is very doubtful whether it would be destroyed by fumigation. It is therefore essential that all cargo and baggage from Samoa should be inspected extremely thoroughly on landing in Fiji. The importation of the early stages of the pest can be prevented in this way, but the possibility of the importation of the adult beetles remains, and is not so easy to eliminate. It is almost certain that the beetles occasionally fly to lights on board ships in Samoa, and it therefore seems probable that they are occasionally brought to Fiji, and will eventually become established unless every precaution is taken. It is impossible completely to eliminate the possibility of importing the adult beetles except by preventing ships from staying in port overnight, a measure which is probably too drastic to be justified; but if such ships were prevented from remaining alongside the wharf overnight, it is most unlikely that any beetles would fly ashore, partly on account of the lights on board and partly because there would be no palms sufficiently near to attract them. As a further precaution, I consider that all palms growing near the wharf should be cut down and that the accumulation of dead vegetable matter in the vicinity of the wharf should be reduced to an absolute minimum. The removal of all palms near the wharf would be fully justified in this connection, as a precaution not only against Rhinoceros Beetle, but also against other coconut pests.

THE EXTERMINATION OF THE RAT.

By H. R. Surridge, A.R.C.Sc.(I), Government Agronomist.

In view of the serious damage caused by the destruction of young nuts in our coconut plantations by rats and the damage to foodstuffs in houses, general stores, &c., a resumé of the various methods of control adopted in other countries should be of service to those interested in the extermination of this serious pest here in Fiji.

The literature on this subject is continually being added to, and the general public are gradually becoming aware of the seriousness of the rat menace to human life, health, and prosperity. That it is a menance to our lives is demonstrated by the tremendous loss of life in historical times in England, Europe and other countries, and at the present time in India, through the Bubonic plague. Health is endangered through the contamination of foodstuffs, whereby the minute organisms causing various diseases are passed on to us, *e.g.*, trichinosis, tapeworm, parasitic mange, and trypanosomasis (sleeping sickness).

Some authorities consider that dengue fever is distributed by the rat. It is certain that in some rat infested areas, notably in Athens (Greece), dengue is prevalent, whilst it is unknown in the clean areas. The same has also been noted in Natal, South Africa.

Prosperity is affected by the loss of foodstuffs destroyed and damaged by this pest, and by the damage to buildings, dams, ropes, &c., which, while apparently small, is not appreciated until a dam or a rope suddenly collapses, with possible loss of life. Owing to the general character of such damage, it is not apparent to the public. Merchants, in assessing their profits, realise that a considerable loss is due to rats, and so regulate their prices as to cover such losses. This might be termed " the indirect taxation by the rat," since the levy of the rat is passed on to an unsuspecting and unthinking public. If such losses could be obviated by the extermination of rats and mice, the general cost of living would be somewhat reduced, the people's health safeguarded, and the risks of epidemics minimised.

Consideration of the three points just briefly discussed shows that the activities of the rat spell loss of life, health and money to the human race.

History.—The rat, like the poor, is " with us always," and according to historical records, has always been with us, and always as a menace. In ancient Egypt its destructiveness to foodstuffs was such that the Egyptians, appreciating the cat as a natural protector of grain or foodstuffs against the depredations of rats and mice, deified the Cat and worshipped it accordingly. Most of the plagues of history, which have caused grave loss of human life, can be traced to the rat as the carrier and distributor of the fatal bacillus, the most common being the famous " Black death " or " Bubonic plague " bacillus. With such a record, the slogan should be " kill that rat."

Varieties.—The varieties of rat most common in these islands are:—

(*a*) The Brown or Hanoverian rat (*Rattus norvegicus*), probably brought here by ships, either to the various ports, or when such vessels have been wrecked and cast ashore.

(*b*) The Alexandrian rat, (*Rattus alexandrinus*), the fur of which is longer and lighter in colour than in the case of the brown rat.

Mice are just as obnoxious as rats, but as they are smaller and not so fierce, the danger through food contamination by them is apt to be forgotten.

Legislation.—In Great Britain and other countries, legislation has been enforced, making it an offence to harbour rats or mice on one's premises, and fines are imposed on those contravening the law. Local authorities and the Ministry of Agriculture in Great Britain organise annually what is termed "rat week." This is one week of the year set aside for rat destruction, and the time chosen is that when the rat migrates from the field to the houses, buildings, towns, &c. In cold countries such migratory movements occur, there being two periods in the year for the rat. The first is early in spring when the migration is from the towns, houses, &c., to the field, the second in late autumn when the reverse movement occurs.

Here in Fiji, owing to climatic conditions, there is no clear differentiation between summer and winter, with the result that no migratory movements, similar to those of cold countries appear to occur. It has been noted however, in coconut plantations, that rat damage appears to be more intense during the dry season than during the wet season, thereby suggesting that a certain amount of migration from the ground to the trees and vice versa occurs between the two seasons. Whether there is actually a definite migration at a more or less definite time has not yet been noted. This matter requires investigation, for if such a movement does occur, then the knowledge of it would assist the institution of measures of control.

Control Measures.—Measures of control are not easy to suggest, since many that are suggested are also fatal to human beings, domestic animals and birds. Therefore, in considering control measures, it is necessary to devise means which, if possible, are fatal to the enemy only. Roughly there are four possible measures of control, three which are more or less in common practice, and one which while the ideal method, has not yet been perfected. The methods in use are as follows:—(1) natural enemies, (2) trapping, (3) virus, (4) poisons.

(1) *Natural Enemies.*—These include dogs, cats, mongoose, owls, the kestrel, magpies, snakes, and last but not least, the rat itself. Most of us are familiar with the dog, cat, mongoose, &c., as rat destroyers, but few appreciate the use which can be made of the male rat as an exterminator of his own kind.

Of the natural enemies named, the mongoose, in Fiji, is perhaps the least appreciated, owing to its habit of apparently preferring one's poultry to rats. It is possible however to utilise the mongoose in islands where rats are prevalent, but to which the mongoose has not been introduced. This may be accomplished by the expedient of trapping the mongoose, retaining the males and liberating them (males only) on those islands at present suffering from the pest. Such a scheme should result in the destruction of the rats, and the ultimate death of the mongoose. To attain such an end, it should be possible to breed the mongoose in captivity, to secure the males required.

Our experience with owls is limited, but given the right breed of owl, once these are established, they will exercise wonderful control over the rat. Mr. Moore Hogarth, in his book, *The Rat—A World Menace*, gives an instance where an owl with young had destroyed, in one night, 19 young rats and 27 mice as well as other vermin.

The kestrel and the magpie also account for a considerable number of these vermin, whilst certain snakes, harmless to human beings, are excellent in cleaning up rat infested areas. It is unfortunate that here in Fiji such snakes are rare, owing it is believed, to the activities of the mongoose.

Finally, there is the rat itself to be considered as its own exterminator. Two methods are possible, and these can be combined to form a very useful and effective measure of control.

The Rodier Method named after its inventor, an Australian, Mr. W. Rodier, is briefly to catch the rats alive, destroy the females, release the males, recording the number of females destroyed, and for the purpose of identification, cutting off half the tail of each male rat released.

The theory of this method is that under normal conditions the rats live in a polygamous state, which condition is conducive to prolific reproduction. Releasing the males and destroying the females tends to bring about a monogamous state, which state tends to restrict reproduction, by the males harassing the females, breaking up the nests, and destroying the young. Therefore the greater the number of males the quicker the extermination of the rat.

The second method is to foster the male rat's cannibalistic tendencies. Catch the rats alive, as previously suggested, but before releasing the males, half starve them, and then feed them with rat flesh. After a few days on this diet, release them. Such rats will prefer rat flesh to other foodstuffs with the result that they will fiercely raid the nests and destroy the young, as well as destroy the young rats that have already left the nest.

This latter method has been tried out by the writer, in the neighbourhood of farm buildings, with good results. It has also been stated to be effective on ships (ref.: *The Rat—A World Menace*, page 95).

(2) *Trapping*.—This can be accomplished by using the ordinary wire traps, for live catching, or the popular " break back," the rat-gin, &c. Two very useful traps which can be made at home are—

(*a*) sink a barrel, cover the top with strong paper and place bait in the centre of the paper for three or four nights. Then slit the paper in the shape of a cross, place as usual. The rats in getting at the bait will fall into the barrel;

(*b*) partly fill a bucket with water, and then fill up with corks to about 4 or 5 corks deep. This, placed between the rats and the bait, will compel the rats to cross the bucket, so that the corks will take the first weight of the rat but not the full weight, with the result that the rat falls through the corks and is drowned.

Another type of trap, which however is expensive, is made by using " Rat-lime " or a similar preparation. This is spread on a board, the bait being placed in the centre, or possibly the lime could be spread around the trunks of trees, one-eighth of an inch thick and about a foot wide. The rats in trying to get to the bait get stuck in the lime, and in struggling to free themselves get the nose or mouth embedded in the mixture and are suffocated.

(3) *Virus*.—The use of a contagious virus is probably the ideal method of rat extermination. Unfortunately, no virus preparation has yet been found which will automatically destroy the rat and not infect other animals including human beings.

Various preparations are on the market, which contain a virus and a poison so that their efficiency is probably due more to the poison than to the bacillus included in the preparation.

(4) *Poison Baits*.—Various poisons can be made use of, but the difficulty, when setting poisoned baits in the field or elsewhere, is to ensure that domestic and other animals will not get those baits, with fatal results. Two substances are in favour, one, Barium Carbonate, which is poisonous to rats, human beings and animals generally, the other, Red Squill Powder, which appears to be fatal *only* to rats, domestic animals and others not being affected by the amounts used.

(1) *Barium Carbonate.*—This is one of the most efficient of poisons, provided it is mixed with the right base. The British Ministry of Agriculture recommend a one-in-four mixture. Some maintain that a one-in-seven is strong enough. Barium Carbonate is a heavy white powder, mildly poisonous, tasteless, odourless, slow in action and inexpensive. While poisonous to rats, it is also poisonous to other animals so that great care must be exercised when distributing the baits.

To prepare the baits, all the ingredients must be thoroughly mixed, and if the baiting is done during dry weather, add sufficient water to make the baits rather mushy, since such baits are more attractive to the rat, particularly when water is not readily available. A variety of baits, used separately, gives the rat a free choice and enhances the chances of the baits being taken.

When mixing or laying baits, it is useful to keep the hands oiled with coconut oil, rancid if possible, since this will help to disguise the human smell, and help to allay the suspicions of the rat.

The following recipes will be found useful:—

(*a*)	Barium Carb.: (commercial)	5 parts by weight.
	Flour	2 parts by weight.
	Cheese	10 parts by weight.
	Glycerine	3 parts by weight.

Thoroughly mix and then make into a stiff dough, roll out on a pastry board and cut into squares, making 1,400 tablets for each 1 lb. of Bar.: Carb.: used. Bake lightly and sprinkle with flour flavoured with aniseed.

(*b*)	Barium Carb.:	1 part.
	Flour	3 parts.
(*c*)	Barium Carb.:	6 oz.
	Meal (any corn meal will do)	16 oz.
	Dripping	4 oz.
	Salt	½ oz.

Mix thoroughly. This quantity should give about 1,000 baits, about the size of a hazel nut. Sufficient oil of aniseed or coconut oil should be used to give the necessary odour.

(2) Red Squill Powder.—This is harmless in the quantities used, to most animals—rats excepted. The chief objection to squill is that it has no uniform toxic standard, so that the commercial product is apt to vary in its efficiency. It is important therefore that the purchaser should secure from the manufacturer or his agent, a guarantee as to the efficacy of that particular product.

In preparing red squill baits, however, with commercial red squill powder it is fairly safe to mix thoroughly 1 part by weight of squill powder to 10 parts by weight of any cereal meal, or peanut meal. Further, squill powder has the advantage of being effective in a dry mixture, and in such a case should keep in good condition for a considerable time.

(*a*) Red squill powder, 1 part by weight; flour, 4 parts by weight. Mix into a stiff dough with water; roll out and cut into biscuits, making 700 biscuits for each ½ lb. of squill powder used. This gives about 5 grs. to each biscuit. This form of bait keeps good a long time.

(*b*) Red squill powder, 2 parts; finely chopped bacon, 3 parts; meal enough to make into a coherent mass, then bake in small cakes.

(*c*) Red squill powder can be dusted on fruit, for example, 1 oz. will be enough to sprinkle 3 bananas sliced into 48 pieces, that is 16 pieces to each banana.

Other poison baits, such as arsenical compounds, strychnine, phosphorous, &c., can also be used, but these are very deadly to stock and human beings.

Laying of Baits.—Before poisoned baits are laid, it is advisable to use non-poisoned baits for the first 3 or 4 nights, to get the rats accustomed to the new diet, and then lay the poisoned baits, using an excess number of baits to secure the greatest kill. A fortnight at least should elapse before using baits a second time in one place. Baits should be laid in the evening, and those remaining should be gathered up next morning. In this way a record is obtained of possible casualties, and reliable knowledge gained of the effectiveness of any one kind of bait.

Procedure.—For the plantation, as well as the town, there is only one successful way of tackling the rat pest, and that is by continuous consistent effort on a co-operative basis. Obviously the individual planter cannot meet with success, single handed, except perhaps in the application of the Rodier method. In England and on the continent of Europe, societies or clubs exist for the destruction of these vermin. Such a scheme could be applied here through the various Progress Associations that exist in these islands.

To summarise, there are four main methods of control:—(1) natural enemies, (2) trapping, (3) virus, (4) poison baits.

No one method is perfect, so that a combination of methods is essential. To ensure that these methods have their quota of success, co-operation between the people of any island or district is essential, otherwise the individual who is endeavouring to rid his place of the pest is continually being reinfected from his neighbours' premises. Whatever measures are adopted must be applied continuously and consistently until the pest has been exterminated.

In all cases it is advisable to prebait for a few nights, and then apply the traps and/or baits to secure as large a bag as possible. Allow intervals of about a fortnight to elapse before repeating the attack. Finally, keep a record of all casualties as suggested by the number of baits taken, so that definite knowledge may be obtained of the effectiveness of the system in operation for the expenditure involved.

Amongst the various publications dealing with the rat pest, the book *The Rat—A World Menace*, by Mr. Moore Hogarth, published by John Bale, Sons, and Danielsson, Ltd. London, price 7s. 6d., will be found useful to those interested in the destruction of vermin.

SPECIMENS FOR IDENTIFICATION.

By H. R. Surridge, A.R.C.Sc.(I)., Government Agronomist.

One important function of the Department of Agriculture in a Colony such as Fiji is the identification of various botanical and zoological specimens, which from time to time are sent in by various interested people, the interest being aroused mainly through the specimen causing damage to their crops, live stock, buildings, &c., In view of the increasing number of such specimens received in Suva, and the importance of making as rapid an indentification as possible, it is not out of place to publish a few simple directions as to how to collect, prepare and forward such material to the Department of Agriculture.

(1) BOTANICAL SPECIMENS.

Collection.—The great aim to be kept in view in collecting is to obtain as perfect and comprehensive a specimen as possible; that is one showing every part of the plant, root, leaves, flowers, and fruit. It is not always possible to show all these details on the one specimen, in which case several would be required to cover these essential features.

Where it is not practical, from its size, to collect the whole plant, the leaves from the root, stem or lateral branches should be taken, and the flowers collected. It is necessary to ensure that all types of flowers from the one plant, shrub, or tree are forwarded, owing, as in the case of the coconut, to two different types of flowers—male and female—being carried on the same tree, or as in other cases, on different trees.

Specimens should be forwarded in duplicate, if possible in triplicate, since it is sometimes necessary to send specimens away for identification, in which case, one can be retained here for future reference. All possible information should be given as to where the plant is found, the type of soil favoured, whether it grows in the wet or dry zone, the season of flowering, whether annual, biennial, or perennial, or other peculiarities or points of interest noted; in short, the plant's history as known to the collector.

Preparation.—Lay the specimen, if possible, between sheets of paper, and when ready for despatch, tie in a parcel stiffening the parcel by backing it with a piece of thin wood or similar material. This will minimise risk of damage in transit.

Diseased Specimens.—When diseased specimens are being forwarded for the purpose of diagnosis, they should be carefully wrapped up, and if of considerable size, wrapped in sacking or similar material so that during transit to Suva no part may be lost, and the plant, leaf, or whatever section is forwarded for examination, may be received as near to its original condition as possible with the diseased parts showing clearly. This will facilitate identification. As a case in point: a coconut leaf was recently received at this office, it had been cut off the tree, carried at least a quarter of a mile through the street, on a man's shoulder, waving in the breeze. On arrival it was thrown down on to the floor of the verandah, and the writer asked to diagnose the injury. Owing to the method of transport and manner of delivery, no insect life was visible, an important omission in this case, because the damage to the leaf suggested the presence of insects, one of which was the dreaded Levuana moth. Had this leaf been carefully taken down, the leaflets tied to the midrib, and the whole carefully despatched to the office, the larvæ or the adult insect would probably have been found and so the cause of the damage attributed to the moth *Agonoxena* would have received confirmation on finding the insect present. Since the damage done by the moth *Agonoxena* can be confused with that caused by the Levuana moth, this example demonstrates that care is essential when forwarding specimens for identification.

(2) ZOOLOGICAL SPECIMENS.

Collection.—In collecting these specimens, particularly the various insects, &c., which damage our crops, every endeavour should be made to capture them alive and in the act of committing the damage complained of. From purely a collector's point of view, it is of interest to know on what an insect feeds, and to work out its life history. From an economic point of view, it is essential to know on what an insect feeds, at what particular stage in its life history it does the most damage, and is the most susceptible to measures of control.

Preparation.—In forwarding such specimens, it is as well to include plenty of foodstuff to last out the journey and allow for a surplus to carry on with on arrival in Suva. When the specimen is small, the usual tobacco tin will be found very useful to send it in, while the larger specimens a wooden box or a cardboard carton would serve. In many cases it is sufficient to secure plenty of food material, and carefully wrap with sacking when forwarding to Suva. In all cases, however, all possible information should be given to facilitate identification.

When forwarding moths, butterfles, beetles, &c., lay them in tissue paper or similar material, to prevent movement during transit and to ensure reasonable condition on arrival. Here again the tobacco tin, match box or other receptacle, according to size, is of service.

It is essential that all receptacles used for sending insects to Suva should be absolutely ant-proof, or else that some deterrent, such as carbolic acid, should be enclosed with the specimens. Napthalene is useless for this purpose.

All specimens, botanical or zoological, should be addressed to the Director of Agriculture, Suva, and marked " Specimens Urgent."

THE FRUIT FLY.*

It is greatly to be deplored that the Mediterranean fruit fly should have recently made its appearance within the borders of the United States of America—an invasion that again brings to the fore the very important questions relating to the introduction of new pests into countries, and to the efficiency of the methods of preventive inspection and quarantine legislation at present in vogue and which concern nearly all the agricultural departments in the world. The rapidity with which the fly has spread from its supposed original home—the Mediterranean countries, the havoc which it has caused on its trail through Bermuda, Hawaii and the Azores, where it has destroyed important fruit industries, the difficulties which it has given to fruit growers in Spain, Italy, South Africa and Australia, all have been sufficient warnings to Americans of the very great dangers fraught with this pest, and of the necessity of keeping it out of their own country. And yet, their very laudable efforts in setting up elaborate and costly machinery to prevent such an invasion have signally failed and it is now feared that if this fly is not exterminated it will spread in the southern states and become a serious menace to the great fruitgrowing districts throughout the warmer regions from the Atlantic to the Pacific coast. Such a state of affairs leads us to discuss briefly some views on the fly itself and of the ways and means by which noxious insects can be spread and be prevented from spreading.

The Mediterranean fruit fly which is undoubtedly one of the most dreaded and destructive fruit pests in the world, was first recorded in American regions when it invaded the Bermuda Islands shortly after the middle of the last century, and again about 1910, in the Hawaiian Islands. Fortunately for the West Indies and Central America, it has not yet, to our knowledge, found its way there, although it is now distributed throughout the tropical and sub-tropical parts of the world. Its foods include a wide range of fruits and vegetables and the damage is caused by the maggots

* From *Tropical Agriculture*, Sept., 1929.

which hatch and feed within the ripening fruit, thus spoiling it for the market and often rendering it totally unfit for human consumption. When it became known in April last that the fly had been discovered and identified in Florida, the United States Government and the Government of the State of Florida immediately put forward a most energetic campaign. Funds were provided by the Governor of the State and the President of the Nation, and inspection and clearing up services started in an attempt to eradicate the pest before it should spread beyond the limits of the 80 square miles which were at first found to be infested.

It is from about 1910 that the United States Government has maintained a quarantine inspection service at all ports of entry and frontier points. Fruit flies, the Mediterranean and others, and several species of insects, as well as diseased plant material are intercepted in commercial cargoes, in passengers' luggage, and even in their pockets. Reference to quarantine reports will show that thousands of interceptions are made each year, and whilst many of these are well known pests and diseases, others are insects and fungi which might become of economic importance. Although the American preventive inspection and quarantine service has been remarkably efficient it has not always, unfortunately, proved absolutely infallible. Before it was established, the country had been invaded by the Mexican cotton boll weevil, the San José scale, the Gipsy Moth and other pests of primary importance, but even since the existence of this service, pests which may prove of equal importance have found their way in and amongst these must be mentioned the pink bollworm, the Japanese beetle and the European corn borer. The European corn borer is already invading the great corn belt, the Japanese beetle is thoroughly established in certain eastern localities while in the case of the pink bollworm of cotton, hope is still expressed that the pest may be exterminated.

There are very few countries now which do not harbour some important pest which has been introduced through the ordinary channels of commerce and although routine methods of transmission in cargo or passengers' luggage are well understood, and can be reasonably controlled it is not so easy to guard against unforseen methods of ingression. The introduction of insect pests has often been shown to be due either to the carelessness of those who should have been better informed or to complete ignorance, as some of the following examples will show. A few years ago, at the San Franciso Exhibition, samples of cotton from China were shown which were found to be infested with the pink bollworm and indeed proved to be the first record of the occurrence of this insect in that part of the world. In California a law prohibiting the importation of live insects into the State was unintentionally violated by somebody sending a parcel from Kansas containing living grasshoppers which were to be used in trick photography. The collection of souvenirs consisting of twigs and fruits is another way by which pests are scattered and this method is often in evidence in the small West Indian Islands, where tourists take cotton bolls, fruits, pods or leafy twigs in one place only to discard them the next day in a shrivelled condition in another colony. It is not known how the Mediterranean fruit fly entered the United States, but it is probable that something unforeseen gave the insect its chance to establish itself.

The Mexican fruit fly or Orange worm is another pest against which an intensive quarantine inspection has been maintained. This insect, also, got past the quarantine barrier early in 1927 and has caused a short war of extermination on a restricted area in Texas. This seems to have been

successful for although the insect is commonly to be seen in the market of Matamoros in Mexico, it has not been recorded on the Texan side of the Rio Grande for about two years.

The greatest danger in the distribution of crop pests and diseases undoubtedly lies in the rapid growth of modern transport facilities which bring with them an increasing number of cargoes and passengers—both potential sources of infection. To this must be added the fact that the balance of nature has been considerably disturbed through the opening and planting up of virgin areas which are fresh ground for the successful development of certain insects. With the help of trade the latter have in turn been exported from their native haunts to new localities, where, no longer under the control of their natural enemies they have done irreparable damage. In fact, the further the problem is studied the more complicated it becomes and the more difficult it will be to find successful means of controlling known pests. The war with insects which began with civilization can never cease and in future only partial control can be hoped for. At present such control consists of the use of poisons, the encouragement of natural enemies, the development of immune or resistant strains of plants and an understanding of the relation of plants in good health to immunity from attacks from certain types of insects. All, although they are not absolute means of control, have their value, but often some trivial and entirely unsuspected circumstances may give an opportunity for invasion, even with the best inspection service. As civilization further progresses the problems to be tackled by entomologists will become more and more intricate but this should not deter the layman from doing his share by studying when he can those pests which may well become a very great danger to the community of which he is a member.

FRUIT FLY CONTROL.

Among the fruit flies, the chief offender in Fiji is *Dacus passiflorœ*. Although Fiji is specially suited for biological methods of control I do not recommend them in this case. Chemical methods (spraying and poison baits) are practicable, but would require very careful organisation on a large scale if they are ever to be effective.

The greatest difficulty is the abundance throughout Fiji of guavas and other native fruits in which the fruit flies breed, and unless these were tackled at the same time as cultivated areas, very little good would result. At the present time, the growing of citrus fruits in Fiji is a very casual haphasard business, and in such circumstances control measures are not worth while. Even if they were begun in a proper manner they would not be maintained with sufficient regularity to be effective.

If, however, extensive cultivation of citrus fruits is contemplated, a campaign against fruit flies would be well worth while. It would be possible and practicable to reduce the quantity of fruit flies very greatly by chemical means if the areas under citrus were large and well cared for. In such circumstances I would recommend the use of poisoned baits (rather than spraying) in conjunction with the destruction of all wild fruit trees in the neighbourhood.

BALED COPRA.*

By C. D. V. Georgi, Acting Agricultural Chemist, and F. C. Cooke, Assistant Chemist for Copra Investigations.

INTRODUCTION.

The usual method of packing copra is to suspend an open sack from the roof of the copra store and to compress the contents by means of heavy poles used as rams. By this method two coolies can fill ten bags, each containing a picul of copra in one hour. For shipment to Europe, new bags costing 50 cents each are frequently employed, having a capacity of between 133 lb and 2 cwt., while second-hand bags are almost invariably used for the local sale of copra.

THE PROPOSAL TO BALE COPRA

It has been suggested that the effective space, occupied on ships and in godowns by a ton of copra, can be reduced, and pilferage controlled by packing well-dried, good quality copra in the form of compressed, oblong blocks of uniform size and shape, and weighing two cwt. each. Such bales can be handled, stacked and checked easily and well, and, provided that the moisture content of the material was less than 7 per cent. resistance to mould growth, to the development of acid and rancidity and to insect attack would possibly be greater than when copra is packed in sacks.

DESCRIPTION OF PLANT AND PROGRESS.

As is the usual practice with " mixed " copra for export, the copra is first sorted to remove bad pieces of " F.M." (fair-merchantable) quality. The good copra of F.M.S. (fair-merchantable, sun dried) quality is chopped by women to give eight pieces per nut. This sizing, which assists compression of the bale and encures a cohesive block, could alternatively be done in a turnip cutter.

The practice of chopping after drying is already practised on some estates, end serves to ensure a product of uniform and convenient size; to improve the appearance of the copra; to prevent the accidental inclusion of dirt, foraign matter and pieces of second quality copra; to assist further drying; and also to ensure that the copra makes a close and tight pack. On the other hand it might be better to chop the copra in the half dried condition, when it is being removed from the shell; if this is done, the cut surfaces will seal up in later stages of drying and the rate of drying will be durther accelerated and more uniform drying assured.

The following is a description of a baling press which is in operation in Selangor:—

The baling machine consists essentially of a long steel box 4 feet high, with two fixed sides and two hinged sides, and capable of being swung as a whole on a vertical shaft. All the sides are reinforced by strengthening girders, and secured in position by a rapid acting clamping device. The top and bottom of this box consists of two removable, grooved, wooden plates or " platens," strengthened and backed with steel, and making a close, sliding fit with the vertical sides. These " platens " are removed from the machine, and two new pieces of Hessian cloth (40 ft. by 48 in. which will

* Extract from *The Malayan Agricultural Journal*, Vol XVIII, No. 6, June, 1930.

ultimately cover the bale are laid over them, and secured in position. The top " platen " is then fitted to the underside of a stout cross-arm, supported on two vertical joists immediately over the hydraulic ram-head; and the bottom plate is placed in position in a recess at the bottom of the box which is thereupon closed securely by the clamps.

The power to work the hydraulic ram is obtained from a 10 h.p. Tangye engine through a counter shaft, the pressure being applied and controlled by a simple arrangement of levers.

Two cwt. of the chopped copra are emptied into the box and levelled up. The filled box is then swung smoothly into position over the ram head and immediately under the top " platen " suspended from the cross-arm. A pressure of 28 tons is slowly applied, until the copra ceases to compress, through the ram-head to the underside of the lower " platen," the area of which is 384 square inches. The effective pressure on the copra during a compression period lasting 40 seconds, is thus 1·5 cwt. per square inch.

When the limit of compression at this pressure has been reached, the ram is locked in this top position, and the clamps securing the box quickly released. The whole cage then swings clear of the bale, back to its original position where it is recharged. The bale remains held in position between the two " platens " by the locked ram-head, and the copra is thus exposed to view, a solid oblong block, with not a trace of oil exuding from it. The Hessian cloths are loosened from the " platens " and roughly " stabbed " into position over the block of copra. Three " safe-seal " wires are next passed through the grooves in the " platens " so as to encircle the bale and they are separately tightened and sealed by a portable " Griplock " sealing machine. The ram is now released, and the bale trucked away for sewing.

WORKING DETAILS.

	Baling process.	Bagging process.
Maximum throughput of process	17 bales per hour or 34 cwt. per hour.	10 bags per hour or 12 cwt. per hour.
Time for one complete bale or bag	6 minutes	6 minutes.
Weight of packing	4 lb to 2 cwt. of copra	2 lb to 1 picul of copra (equivalent to 4 lb to 2¼ cwt.).
Cost of packing materials ..	45 cents a bale or 23 cents a cwt.	50 cents a bag or 38 cents a cwt.
Pressure applied at ram	=28 tons.	....
Pressure on the bale	=1·5 cwt. per square inch.	....

It is not possible to give details of the labour requirements until the present plant is on a full-time regular production.

THE BALE.

The finished bale is a very neat oblong block of a convenient size and shape to handle. Four pieces of split bamboo which are inserted with the Hessian cloth under the wires, serve to keep the bale rigid and compact, and prevent the wire cutting into the copra and so loosening during the vibrations of transport.

The volume occupied by the two cwt. of baled copra is under 5·3 cubic feet, as against 8·3 cubic feet for the same weight of copra in sacks and the overall dimensions of the bale are 25¼ in. by 17 in. by 21 in. The bales pack very neatly and squarely; 84 bales arranged in a stack, 7 high, 4 wide, and 3 deep, occupy 49 cubic feet (12 ft. 7 in. by 9 ft. 3 in. by 4 ft. 2 in.). Thus the " broken stowage " for 100 bales (10 tons 4 cwt. in weight with packing)

will be 58 cubic feet. At present, because it is a bulky commodity, 12 cwt. of bagged copra are charged freight, as though they weighed a ton, whereas if the copra were baled, a ton of copra could be freighted as such without correction, and 8 cwt. stowage could be saved.

POSSIBLE OIL LOSS DURING BALING AND SHIPMENT.

(*a*) *By compression.*—Although the pressure is gradually applied to the loose copra and is only of 40 seconds duration, it might be thought that oil would be lost. There is, however, no sign of loss of oil, nor darkening of the floor immediately underneath the press, and if the hand is rubbed over the exposed block of compressed copra, it will be found to show no trace of exuded oil.

The bale of copra is wired and left in compression, so that the pressure is maintained, until the block is broken up. It could be argued, therefore, that the vibrations and shocks of transport might cause oil to exude and be absorbed in the Hessian covering material. There is, however, no loss of oil on this account.

(*b*) *By self-heating.*—In a single bale of copra, the facilities for heat escape may be worse than from the centre of a bag of loose copra. It is almost certain however that a stack of bales is better ventilated than a stack of bags because of the straight channels and connected air gaps which must separate each bale and allow free passage of the cooling air. In a heap of bags, the air spaces which exist inside are generally sealed at some point by the weight of superimposed copra.

When copra deteriorates, heat is liberated and, under the conditions existing in a stack of sacks in the hold of a ship, is accumulated to the further detriment of the copra and the production of free acidity, moisture, colour and rancidity with loss of oil.

It will be seen, later, that in the trial shipment of good baked copra, no oil loss whatsoever has occurred, and that the free acid formation is somewhat less than the average for sacked Malayan copra of good quality.

CONTROL ANALYSIS OF A TRIAL SHIPMENT OF COPRA.

A small quantity of copra was taken from each bagful of a large consignment of copra, prior to baling. This total sample weighing about 360 lb was then well mixed, spread evenly on the floor, and the pile divided into four quarters. The copra from two diagonally opposite quarters was taken for pressing into a sample control bale, to be kept in the store shed of the Department of Agriculture, and the copra of the remaining two quarters was then "quartered down" until only 10 lb was left. From this small amount, three samples were drawn for determination of the percentages of moisture and oil in the copra, and of the acidity of the cold expressed oil. The loose copra still remaining was then placed in a sack and stored under the same conditions as the control bale. The results of the analysis, and the appearance of the copra indicate that the copra was of normal good F.M.S. quality.

ANALYSIS PRIOR TO DESPATCH.

Test.	Sample. No. 1.	Sample. No. 2.	Sample. No. 3.	Average.
Moisture per cent.	6·8	6·7	6·7	6·8
Oil per cent. (wet basis, copra as received)	60·1	60·9	60·6	60·6
Oil per cent. (dry basis)	64·6	65·3	65·0	65·0
Acidity per cent. (as lauric acid) ..	·65	·74	..	·70

The main consignment of bales was despatched to Europe and two months later the control bale and sack of copra stored at the Department of Agriculture were re-weighed and tested with the following results:—

ANALYSIS AFTER TWO MONTHS.

Loss in Weight.

Pack.	Nett weight, June 25th.	Nett weight, August 27th.	Per cent. loss in weight.
Bale	229 lb	224 lb	2·2
Sack	113 lb	111¼ lb	1·3

Acidity of the Cold Expressed Oil (as Lauric Acid).

Sample taken from	Date.	Acidity per cent.
Loose copra before baling	June 27	.. ·70
Copra from centre of bale		1·72—Aver. 1·44
Copra from outside of bale	Aug. 25	1·16—
Copra from sack	Aug. 27	.. 1·43

There was little evidence in either case of mould growth, although in both cases the copra had been attacked by a variety of insects. The stored bale showed no signs of oil exudation, nor were there any indications of the copra becoming self-heated by deterioration in the absence of freely moving cooling air within the bale.

The main consignment of this copra, despatched to Europe in baled form, arrived at its destination in August, where it was analysed both by the consignees (*c*) and also by an independent arbitator (*a*).

COMPARATIVE RECORD OF ANALYSIS.

Total Oil Content before and after shipment.

		Weight. Cwt.	Oil per cent. (Wet basis).	Total oil. Cwt.
Loose copra before baling		1,904¾	60·6	1,152
The same copra as received in baled form in Europe	(C)	1,845¾	62·8	1,158
	(A)	1,845¾	64·0	1,180

Quality.

Sample taken from		Moisture per cent.	Oil per cent. (Dry basis).	Acidity per cent.
Loose copra before baling . ..		6·8	65·0	·70
Stored in Malaya (baled) . ..		..	..	1·44
(sacked) . ..		..	..	1·43
Baled copra as delivered ..	(C)	4·5	65·8	1·51
	(A)	4·6	67·2	1·48

Per cent. Loss in Weight in two Months.

Circumstances.	Loss in weight. per cent.
During storage in Malaya—as a single bale	2·1
Do. as a single sack..	1·3
During shipment to Europe in baled form	3·0

From the above it will be seen that the copra does not lose oil during baling or subsequently during shipment and storage. The slight differences in the calculated amount of total oil are within the limits of experimental error if consideration is allowed for possible differences of method, and for personal error.

The acidity of the oil was determined here on the cold expressed oil and not on the oil extracted by solvents, the latter giving slightly lower results. It would appear that, in spite of the cooler conditions on the way to Europe, the stacked bales deteriorated slightly more than the solitary control bale kept at the Department of Agriculture, whilst the loss in weight was also greater, though of course the conditions of storage were very dissimilar.

THE DETERIORATION OF STRAITS F.M.S. COPRA DURING SHIPMENT IN SACKS TO EUROPE.

Eighteen large samples of F.M.S. copra from various estates in Malaya gave the following results on analysis:—

Moisture per cent.			Oil per cent. (dry basis).			Acidity per cent.		
Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.
6·9	9·1	4·7	65·9	69·0	62·2	·18	1·00	·03

Seventeen different bulk consignments of Straits F.M.S. copra, received in Europe in sacks, yielded the following figures from the analysis of the consignees:—

Moisture per cent.			Oil per cent. (dry basis).			Acidity per cent.		
Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.
4·7	5·5	3·9	65·0	67·0	63·6	2·25	5·06	·35

It will be seen that the average acidity has increased from ·18 per cent. to 2·25 per cent. for copra in sacks, whereas the trial shipment of baled copra only increased in acidity from ·7 per cent. to 1·5 per cent. The loss of moisture for copra in bales and in sacks, is however, identical.

CONCLUSIONS.

1. There is no indication of loss of oil during or after baling when the copra is properly dried, is of genuine F.M.S. quality and is packed cold.

2. There is no evidence that the copra deteriorates more when in the form of compressed blocks, than it does when stored in sacks, in fact there are indications to the contrary.

3. The system of chopping before baling will ensure product of uniform and convenient size which will be easy to handle by the crushers, and will also prevent the accidental inclusion of dirt and foreign matter by the producer.

4. Baled copra is convenient for handling, stacking and checking.

5. The trial shipment arrived in Europe "intact and in good order."

6. The effective space occupied by copra in baled form is one-third less than when stacked in sacks.

7. In conclusion, the writers wish to record their thanks to Mr. F. W. Douglas for technical assistance in this inquiry; also to Mr. Gunn Lay Teik for carrying out the analytical work.

The dollars quoted in this article are Straits Settlements currency $1=100 cents=2s. 4d. Also 1 picul=100 katis=113⅓ lb.

For explanation of the significance of oil per cent. (wet basis) and oil per cent. (dry basis) see *Malayan Agricultural Journal*, Vol. XVII, Sept., 1929, No. 9.

MAIZE.

AUCKLAND merchants object to Fijian maize because of the presence of weevil in practically all consignments. This fault could be removed by fumigation, which is an expensive process, that could, however, be economically carried out prior to shipment. The only method of satisfactorily drying maize artificially is by dehydration, which shrinks the grain to such and extent that it is almost useless after treatment.

The present duty in New Zealand is 2s. per 100 lb plus 22½ per cent., with no primage; that is to say 2s. 6d. per cental.

April, May and June are the best months to ship maize from Fiji in order to reach the market before maize from South Africa arrives, which is generally about the end of June. Prices are usually steady during these months. The values during 1930 were from 6s. 6d. to 6s. 9d. a bushel. A good market exists in New Zealand for Fijian maize provided that the weevil can be eliminated before shipment and the grain is thoroughly dry and hardened.

(*Note.*—Duty of 2s. 6d. per cental is equivalent to 1s. 4½d. per bushel. Freight costs 55s. per ton, wharfage 1s. 10½d per ton, making total charges f.o.b. Suva to c.i.f. Auckland 2s. 9½d. per bushel, cartage extra).

Unless Fijian maize can be landed in New Zealand at very cheap rates it would be useless to export during the months of July to December. From December to July African and Java maize is imported in large quantities into New Zealand but only at such times when the locally grown maize is in short supply or is being sold at prohibitive prices. In New Zealand, African and Java maize is quoted c.i.f. at 160s. to 195s. equivalent to 4s. to 4s. 11d. per bushel. On August 6th, 1930, quotation for African importation, shipment *via* Australia was 151s. per ton c.i.f. & e., New Zealand ports.

One firm states that experience shows that a small, round, hard yellow maize sells better than the large horse-tooth variety. The maize trade in Auckland is amongst poultry keepers only who dislike large grain for feeding purposes. Small immature grain must always be excluded and good packing in clean once-used sacks, well sewn and branded, not exceeding 200 lb per sack nett will improve the selling value of the maize. The custom is to sell in 400 to 500 tons parcels.

In the earlier days of maize growing in the Bay of Plenty it was considered that shelling of the cobs should follow their storage for six to ten weeks in the crib, and it was seldom that a much longer period was allowed to elapse on most of the farms where the crop was grown. Consequently storage provision was often of a temporary nature, and as the practice of holding the crop for longer periods developed this storage was often quite inadequate, especially where crops were held for as long as twelve months.

Of the cribs built the most satisfactory for the smaller growers was the tapering (from top to base) form. Such a crib was usually 8 ft. to the eaves 5 ft. wide at the base, 7 ft. wide at the eaves, and varied in length, according to requirements, from 12 ft. to 25 ft. As the tapering sides were subjected to severe strains when the crib was filled it was found necessary to provide wall supports in the structure, spaced at 3 ft. to 4 ft. intervals along each side. With the shorter cribs a door at one end was sufficient for convenience of filling, but where the length approached or exceeded 20 ft. it was found desirable to have a door at each end. In some cases landing-stages were built for convenience in filling, but it was found desirable that these should be movable so that they could be dispensed with at shelling.

A modification of this type of crib has arisen through a desire to reduce expenditure. The sides in this case are vertical, being constructed of spalings spaced at 4 ft. intervals with longitudinal battens to support the wire netting which is used to line the crib. The roof is of the lean-to type. This is perhaps the least desirable of all types when storage is required for long periods, as losses due to birds, mice, &c., are considerable; but where shelling follows harvesting within a short storage period, or where maize-growing is not a regular practice on the farm, it provided the grower with a cheap means of storing the crop.

On the larger maize areas, where considerable space is required, it is often the practice to build two long cribs—up to 40 ft. each in length and parallel to one another—under the one gable roof, with sufficient space between them to provide accommodation for the various farm implements. Doors for filling are usually provided at each end, with sliding-doors situated midway down the inner sides of the cribs to provide means for feeding cobs to the sheller, which is usually brought into the implement space to allow of shelling from both cribs without having to move the machine. These cribs which have vertical walls, are usually 6 ft. wide, 8 ft. to 9 ft. high, and from 20 ft. to 40 ft. in length. In addition to housing implements the space between the cribs promotes air-currents, which materially assist in the drying of the grain. Arising out of the foregoing type there has also been evolved a single crib similar in all respects to each section of the double crib just described.

It is claimed for this type of crib that owing to the vertical walls there is far less strain on the walls than in the case of the type with tapering sides, and consequently there is no necessity to strengthen the sides with wall supports. Furthermore, greater capacity is claimed without increase in expenditure on timber. A somewhat greater overhang of the roof is necessary, however, to protect the cobs efficiently from the weather. Various other modifications are occasionally encountered, chief of which perhaps is the single crib built on to the back of an implement-shed; but the great majority conform to one or other of the foregoing types.

RECOMMENDED DESIGNS.

With the object of providing information on the construction and cost of cribs embodying the most desirable features, drawings, specifications and estimates were recently prepared by the Agriculture and Public Works Departments for the guidance of growers. Two designs were adopted. A combined double crib and implement-shed, for areas up to 18 acres where the crops average about 50 bushels per acre and a single crib embodying the features of one storage section of the double type, for areas of six to seven acres at a similar crop average.

In explanation of the dimensions given for the cribs it should be understood that heights and widths as specified have been arrived at as the most suitable for promoting best drying conditions. Growers with considerable experience regard 6 ft. to 7 ft. as the greatest width that should be employed in any crib. In regard to height there is a greater range of opinion; but even in this respect few successful growers favour heights exceeding 10 ft; generally 8 ft. is regarded as the most suitable. The length of crib can be varied between wide limits, and will depend to a great extent on the quantity of maize to be stored.

SITE AND POINTS IN CONSTRUCTION.

Realising that the chief point in storing maize cobs in a crib is to provide sufficient aeration to allow the grain to fully mature, it will be at once apparent that choice of site for the crib is of some importance. Air-currents play a greater part in efficiently drying out the grain than does warmth direct from the sun. Consequently, where it can be conveniently arranged, a site near or under a belt of tall trees would be preferred to one in the open, as direct sunlight on the grain bleaches it, thereby making it less attractive when marketed. On no account, however, should a crib be built where the soil is unduly damp, as the moisture in rising has a deteriorating effect on the grain.

It is desirable to have the floor at least 2½ ft. from the ground, so as to allow air to freely circulate beneath as well as around the crib. Rising soil moisture can then escape without in some measure passing into the lower layers of cobs. The flooring itself will be more effective in promoting drying if the boards are spaced so as to allow ½ in. to 1 in. spaces between them. There will be perhaps a slight loss of grain between the boards but this is comparatively insignificant compared with the benefit derived from the improved aeration of the lower portion of the crib.

Walls and ends should always be timbered vertically with 3 in. by 1 in. battens spaced 1 in. to 1½ in. apart to allow of aeration. In addition it is desirable, althought perhaps not essential, to have the crib lined with bird netting so as to reduce losses of grain. A gable roof is much more satisfactory than one of the lean-to type as it is easier to provide adequate overhang with this type for protecting the cobs from the weather.

Tin shields are occasionally employed on the blocks in an endeavour to keep out rats and mice, but, owing to the fact that most cribs are not more than 2 ft. to 3 ft. above ground-level, it is doubtful whether their general use could be advocated. Rats in particular would have little difficulty in jumping from ground-level, but fortunately they are not a serious pest in most cribs in the maize-growing areas.

MAIZE.

By H. R. Surridge, A.R.C.Sc. (I.), Agronomist.

The evidence of history is that maize originated from America. Since the discovery of that country in the fifteenth century, the cultivation of maize has extended throughout the world so that it now holds a leading place with wheat and rice as a staple food crop. The following figures extracted from the *International Year Book of Agricultural Statistics*, 1928–1929, show the important position that maize holds amongst the world's cereal crops:—

Wheat, 1,225,223,000 quintals; Maize, 1,079,119,000 quintals; Rice, 880,163,000; Oats, 731,625,000; Rye, 437,592,000; Barley, 403,964,000. (quintal=100lb).

In Fiji maize has been grown for many years. Seemann in his *Flora Vitiensis*, states that at the time of his visit (1865–1873), "only one kind of corn—a small yellow grained one—was cultivated by the white settlers, the native not having as yet, taken to growing it." Since Seemann's time, with the continued settlement of the country by Europeans and subsequently Indians, the cultivation of maize has extended so that in recent years there has usually been an exportable surplus, varying within wide limits, as shewn by the following figures extracted from the Fiji Blue Books:—

1920, 42,732 bushels; 1921, 62 bushels; 1922, 1,030 bushels; 1923, nil; 1924, 210 bushels; 1925, 2,048 bushels; 1926, 1,513 bushels; 1927, 2,560 bushels; 1928, 3½ bushels,; 1929, 4 bushels.

These fluctuations would appear to be due more to poor quality with the consequent low prices than to prevailing low prices for maize of standard quality.

As a food crop for human consumption it has not yet attained, in these islands, the place it deserves, its present uses being mainly confined to stock and poultry. The crop is a simple one to grow, the plant being adaptable to a wide range of conditions as regards climates and soils, demanding

of the grower a deep preparatory cultivation and subsequent clean land. As might be expected, the cultivation of this crop reaches its highest development in America where its importance as a crop exceeds that of wheat.

Species and Varieties.—The different species show variations in such points as time required for maturing, height of plant, size of leaves, position of the ear or cob on the stalk, the number of ears, the size and shape of the cob, the number of rows of seed, their regularity or otherwise, and the size, shape colour &c., of the grain. These variations are due primarily to the ease with which maize is cross fertilised, so that it is worth noting that the choice of a variety is of much less importance than the improvement of that variety when once chosen.

Selection of Seed.—The fundamental principle behind what is termed "Mendel's Law of inheritance" is that "like begets like." In selecting seed for planting, therefore, particular attention should be paid to the type of seed demanded by the market in which seed the will be sold. In New Zealand a smaller grain is preferred, since most of the maize required is for poultry.

The feeding value of the grain depends upon its construction. The white starchy part contains less protein, that is flesh forming material, than the horny starchy part and is therefore less valuable. The germ, though rich in proteins is chiefly valuable for the oil it contains, so that to secure a grain of high feeding value it is necessary to select the grain with the largest germ and the smallest starch content. Further, the process of selection must extend to the cob by selecting those cobs of the greatest uniformity, with seeds as already described, set in regular rows and tightly packed. The seeds at both ends of all cobs should be discarded since their progeny will not give the desired result. The nearer the cob is, in shape, to the perfect cyclinder, the higher the possible yield.

In maize, colour appears to answer the purpose of identification only; no one colour appearing superior to another. There are three general colours, white, yellow, and red. White is always white and readily distinguishable. Yellow ranges from a pale lemon to orange presenting difficulty in identification only when approaching the border line between orange and red. The reds usually separate out into light reds with a white cap and dark reds without the white cap. In selecting corn, therefore, select cobs of uniform shape, size and colour, discarding all ears which appear diseased, discoloured, irregular in shape, and with rows not straight The longest ears are required together with seed having the largest proportion of germ to starch.

To Produce good Seed.—For those who wish to improve their maize the following is probably the best method to secure the desired result in the shortest time. The method is known as the "ear to row" method, and consists of selecting the best cobs that conform to the required standard, discarding the seeds at the base and tip, using the remainder for sowing. A good cob should give from 400–600 seeds, so that the length of the planted rows will be controlled by the cob with the least number of seeds.

Mark out the rows and sow the seeds of one cob to one row, until all the cobs have been disposed of. The surplus grain, that is the grain over and above that required for the rows, can be mixed and sown in the usual way. It is necessary, however, to isolate these seed rows from the general crop, if possible, by growing another tall crop betwixt the two. The reason for this, as already given, is that maize is cross fertilised so easily.

On the seed crop maturing, the procedure of selection has again to be repeated. In the course of a few seasons it will be found that a very uniform crop can be grown giving a higher return per acre, which will more than compensate for the care and attention given to selection.

Soil.—To secure the best results with maize, good soil containing plenty of humus is required, a condition which obtains most on the alluvial flats and small areas of " bila " land found throughout these islands. A medium to heavy loam is preferable.

Preparation of Soil.—Maize requires deep cultivation, the success of the crop depending probably more on the preparation before sowing than perhaps any other factor. A good deep ploughing, followed by a thorough harrowing to work the land up to a fine tilth is required. Wherever possible, all humus, *i.e.*, dead leaves, stalks &c., should be ploughed in, to maintain the fertility of the soil and improve its physical condition and moisture content.

Planting.—This process can be done by hand or with the aid of a maize drill. The land should be marked out in rows, with the plough, and the seed dropped into the furrow, the furrow being 2 in. or 3 in. deep, at intervals. The distance apart in the rows depends on the method of cultivation following the planting. To drill a field in one direction means cultivating in one direction, therefore single seeds may be sown in the furrow or drill, one foot apart, with the drills four feet apart. If, however, the " check " system is adopted, the field is drilled or lined in two directions, up the field and across the field at right angles, three or four seeds being planted at the intersections of the lines. By this method, subsequent cultivation can be done in two directions by horse or other implements and the land receives a more thorough cleaning and stirring. The distance apart of the lines will depend on the quality of the soil, but 3 ft. to 4 ft. would serve in most places.

In New South Wales the use of a furrow opener in front of the maize drill has been found of service under certain conditions, especially where nut grass is troublesome. The furrow opener consists of a pair of discs set at an angle and close together in front, or a pair of double mould board sweeps which preceed the drill and help to steady the drill in action. Amongst nut grass this method has been found essential.

Season of Planting.—In these islands, maize can be sown at almost any time. That sown, however, at the commencement of the rains would be harvested at the close of the wet season. Such corn will not keep too well and is therefore not good for export. That sown towards the end of the wet season, and harvested during the dry season, will keep better and be more suitable for export. The early sowings are usually attacked by weevils while the later sowings do not suffer so severly.

In considering the New Zealand market, to secure the best prices, maize must be marketed between April and June to catch the market before the South African shipment arrives. If forwarded for sale after June, it must be of the highest quality to compete with the overseas corn then arriving. Therefore, in growing for export, the planting season will be controlled by the final destination of the crop.

Fodder Requirements.—The foregoing directions refer to maize planting for corn production. Amongst the dairy men of these islands maize might be of service as a green fodder, during the dry season when grass nutriment is at its lowest. Maize when sown singly and fairly close together tends

to sucker freely so that a heavy green fodder crop would result from the sowing of single seeds in drills about 3 feet apart. Such maize, however, would not produce a very good quality corn.

Cultivation.—When the plants are one foot high,thin out the weaklings (check planting) leaving one strong plant to each planting hole. This will tend towards maximum yield.

During growth the soil should be worked towards the plants to enable the plant to secure a firm hold on the ground to withstand heavy rains and wind. Shallow cultivation only should be done and continued until the plants are sufficiently high enough to check all weed growth. Several light cultivations are of more benefit than two or three severe cultivations. The necessity is to keep down weeds, maintain a thin soil mulch to allow rain to enter the soil freely and conserve soil moisture.

In New South Wales harrowing is commenced immediately after sowing and continued until the plants are 6 in. or 8 in. high. It is claimed that plants treated this way stand up better against lodging by wind, while the harrowing destroys the weeds and maintains a thin soil mulch.

Manuring the Crop.—Although maize has been grown for a considerable time in these islands no suitable manuring formula has been evolved. Lands that are subject to flooding are usually renovated by that flooding, but where land has not this advantage every effort should be made to return as much as is taken out by the crop. With a crop that is sown for the grain, a heavy drain is made on the fertility of the soil producing that crop, so that every effort should be made to conserve fertility by returning all leaves, stalks, &c. Also experiments should be undertaken with artificial manures to secure the highest return for the money invested.

A useful rotation to work with land given up to maize is to sow Mauritius Bean either alternately or once in every two years. If grown alternately it should be possible to secure a profit from the sale of the bean seed. If, however, the bean is sown once in two years, it would be preferable to plough in the bean crop about flowering time. This would give humus and nitrogen to the soil and succeeding crop with beneficial results.

No system of crop rotation with reference to maize has been worked out for Fiji, but it should be practical to work maize in with a rotation of some leguminous crop, *e.g.*, Mauritius Bean, tobacco, cotton and perhaps potatoes in some districts, with beneficial results to the crops and therefore the producer.

Harvesting.—When the corn stalks have dried, the maize is ready for harvesting. Here in Fiji only the grain is of major importance, so that the cobs are gathered in from the field, husked and spread out to dry. This latter operation is most important for the value of the grain in most outside markets depends upon its dryness; for export it should not exceed 12 per per cent. of moisture. To secure this degree of dryness, very thorough and efficient drying is essential and close attention should be given to the whole operation to secure the minimum moisture requirements of the final market. If the ears are broken from the stalk before the grain is thoroughly dry, considerable shrinkage takes place.

In America and South Africa use is made of the stalk, leaves, husks and shelled cobs for various kinds of stock feeding, the manure results from this feed being returned to the land for the following crop.

Crop.—In most countries 40–60 bushels per acre may be taken as a fair average crop although individual farmers in America and South Africa frequently exceed 100 bushels of shelled corn per acre. In Fiji no reliable

records are available, individual cases of 40 bushels per acre are known and considered very good. From these figures it will be seen that considerable improvement could be made in the growing of the crop here.

Shelling.—This is performed when the whole ear is quite dry and the grains are required for market separated from the cob. Several machines for shelling husked maize are on the market at prices ranging from £2 or £3 to nearly £100. In selecting one the chief point to take into consideration is the amount of corn to be shelled.

Storing.—Maize may be stored with the husk left on or after it has been husked. That with the husk left on suffers less from insect attack during storage. To keep well, maize *must* be throughly dry. Thorough drying of the grain hardens the outer seed coat and tends to reduce the risk of attack from weevils, moulds, &c., at the same time killing eggs and spores that would be present.

Marketing.—All maize should be carefully sorted before marketing, separating all inferior and immature grains particularly, those attacked by moulds or insects, so that the sample offered is sound, clean corn. For the export trade the sample should also be thoroughly dry, *i.e.*, the moisture content should not exceed 12 per cent.

DISEASES AND PESTS.

In Fiji the chief pests of the maize crop appear to be the maize moth and the maize weevil, both attacking the dry grain. Leaf hoppers and aphids are often present on the leaves and leaf stalks but, at present, do not appear to affect the plant or the yield.

The minah is very troublesome amongst young maize in certain localities, the birds rooting up the young seedlings and eating the seed that is still attached to the roots, or, where the seedlings are rather older, breaking the stem of the plant in their endeavours to uproot them. The moth and weevil already referred to, are pests which usually attack the stored grain and therefore concern the large grower and the merchant who has to effect storage pending the sale of the grain.

The maize moth.—These are small greenish-brown moths found in the neighbourhood of stored grain, usually in great numbers, resting during the daytime with the wings close to the sides of the body. In this position the fore-wing shows a dark band across the body about one-third of the way from the base. The hind-wings are pale brown in colour with no particular markings. The wings when expanded measure about three-fifths inches, while the length is about half that. The female moth lays its eggs *on* the husked grain, from which a small larvæ emerges in due course which bores into and destroys the grain, working from one grain to another until fully fed, when it pupates, emerging as an adult moth in 9 or 10 days to repeat the process. This causes considerable damage amongst the stored grain.

Control.—To prevent such damage, the corn should be stored after husking in clean, sound, closely-woven bags. Another method, where practical, is to fumigate the grain to destroy all moths with carbon bisulphide at the rate of 1 lb to every ton of grain or 1,000 cubic feet of bin space. When using this substance, great care must be exercised and all lights extinguished as the poisonous vapour is extremely inflammable.

The grain weevil (*Calandra granaria*).—This is a small brown weevil about one-eighth of an inch in length and, like all weevils, has the typical long snout with which it attacks the grain. Its life history is similar to that of the maize moth, except that in this case the grain is punctured and the egg

is laid *inside*. From this egg a small larva hatches out, feeds in the grain, leaving the outside skin. This is repeated until the larva is fully fed, when it passes through a resting stage to emerge eventually as an adult weevil. The adult weevil also attacks the grain so that the attack is constant and continuous.

Control.—Thorough drying of the grain and good clean, storage go far to reduce the damage caused by this pest. The heating of improperly dried grain during storage establishes favourable conditions for these insects. Fumigation with carbon bisulphide or hydrocyanic acid gas is also a satisfactory method of destroying weevils under certain storage conditions.

GINGER.

INQUIRIES have been received on the subject of the local cultivation of ginger. The matter was referred to the Director of the Imperial Institute, London, whose reply, together with a valuable article on the subject, is published below:—

N. 1173/5. Imperial Institute, South Kensington,
London, S.W.7, 22nd April, 1930.

Sir,

With reference to your letter of the 5th March (No. 341/30) on the subject of ginger, I enclose herewith a cutting of an article on *Ginger—Its Cultivation, Preparation and Trade* from the *Bulletin of the Imperial Institute*, Vol. XXIV (1926), No. 4, which will probably supply much of the information that you require. With regard to possible markets for the product you will note from the section* of the article relative to trade and production (p. 678) that the bulk of the dried ginger produced in Jamaica, India and Sierra Leone is taken by Great Britain and the United States.

There is little to add to the information on methods of cultivation and preparation contained in this article. It may be pointed out, however, that the crop should be prepared in the form of the dried, peeled "root"; the production of preserved ginger such as is shipped from China requires special methods of cultivation and preparation. The market value of peeled ginger depends very largely on the method of preparation and the care with which the process of peeling is carried out. The best Jamaica ginger, for example, is at present realising 71s. to 90s. per cwt. as compared with 45s. per cwt. for the less well-prepared product from West Africa. Twelve months ago, the corresponding figures were 110s. to 120s. and 54s. per cwt. respectively.

Consignments of ginger or other spices could be sold in London through brokers, or possibly direct to merchants. The following firms are interested in spices:—

Brokers—

Messrs. Lewis & Peat Ltd., 6 Mincing Lane, E.C.3.

Messrs. Dalton & Young, 28 Fenchurch Street, E.C.3.

Messrs. Samuel Figgis & Co., 45 Fenchurch Street, E.C. 3.

Messrs. Hale & Son, 10 Fenchurch Street, E.C.4.

* Not published.

Merchants—

Messrs. Joseph Travers & Sons Ltd., 119 Cannon Street, E.C.4
Messrs. Dunlop Bros. & Co., 12 Fenchurch Avenue, E.C., 3.

Consignments should be forwarded through a shipping agent and it would be desirable in the first instance to communicate with the broker or other firm selected, in order that proper arrangements for shipping might be made.

I am &c.,

ERNEST GOULDING,
for the Director.

The bulk of the world's supplies of dried ginger is at present produced within the Empire, in the West Indies, India, and West Africa. Jamaica ginger is of a relatively uniform high grade. Indian ginger is on the whole of somewhat lower quality, although certain kinds, such as Calicut ginger, realise prices approaching those of Jamaica ginger. The ginger produced in Sierra Leone, however, which forms a very large proportion of the material imported into the United Kingdom, is of a lower grade. The Imperial Institute is informed that the United Kingdom market could absorb increased supplies of ginger of the better qualities, and for this reason it has been considered desirable to draw the attention of present and potential producers to the best methods of cultivating the plant and preparing the product for the market. In the case of Sierra Leone and Dominica this has already been done to some extent by means of a memorandum sent recently by the Imperial Institute to the respective Governments of those countries. Through the agency of the present article, it is hoped to create an interest in the product in other parts of the Empire, where the conditions are suitable for its production.

THE GINGER PLANT.

The ginger of commerce consists of the underground stem or rhizome of a herbaceous perennial, *Zingiber officinale*, Roscoe, belonging to the natural order Zingiberaceæ, a section of the Scitamineæ. The rhizome is branched and bears at intervals upright leafy shoots, about 2 ft. high, and, usually distinct from these, an erect flowering shoot.

From very early times the plant has been grown from cuttings of the rhizome and, like certain other plants which are propagated entirely by vegetative means, such as the banana, fertile seed is rarely produced. The cultivated plant consequently shows little variation in botanical characters and the various forms of ginger which appear on the market owe their differences almost entirely to the method of cultivation and preparation practised in the region of production. It was at one time stated that the relatively juicy Canton ginger, from which the Chinese preserved ginger is prepared, was derived from a distinct though related plant, *Alpinia galanga*. This, however, is now known to be erroneous, and the succulence and slight pungency characteristic of Chinese ginger appear to be due to the special methods of cultivation adopted in China and to the rhizome being harvested at a comparatively early age (see p. 12).

The original home of the ginger plant is not known with certainty. It occurs wild in South-east Asia and in the Malay Archipelago, and it has also been recorded in a wild state in Columbia. It has been suggested, however, that the plants found in Colombia are relics of early cultivation, as may possibly be the case also in the other two regions mentioned.

CULTIVATION AND PREPARATION.

Climatic Requirements.

For the successful cultivation of ginger the essential requirements as regards climate are a good rainfall and a high temperature during the growing period. In the ginger-growing region of Jamaica the mean annual rainfall is 88 in., whilst in south-west India it is over 100 in. A dry season during the resting period and prior to planting is an advantage, as it facilitates the thorough preparation of the soil required for the crop, but is not essential.

Owing to the fact that a high temperature is needed for the optimum growth of the plant, cultivation is naturally most successful in tropical and sub-tropical regions. It need not be restricted to such areas however. Provided that the heat and sunshine are sufficient during the greater part of the year, a cold winter is immaterial, as before this period is reached the rhizomes will have been dug up from the ground, the bulk already prepared for the market and the remainder stored for planting the following season. These are actually the conditions obtaining round Canton and also in parts of Queensland where the crop is grown.

As regards altitude the plant succeeds in Jamaica from sea-level to considerable elevations, and in India also it is grown both in the low country and up to 4,000–5,000 ft. in the Himalayas.

Soil and Manure.

Ginger is an exhaustive crop and, unless manures are readily and cheaply available, the soil in which it is grown must be rich in plant food. The plant will not succeed in land liable to become water-logged or in soil of a gravelly or very sandy nature. The most suitable kind of soil, therefore, is a rich vegetable loam. The land must be well drained, as if water collects about the rhizome the latter is liable to rot.

The best varieties of Jamaica ginger are grown on a sandy loam, and in India the ginger produced on the compact black soils is said to be inferior to that grown on the lighter sandy loams. The amount of sand should probably be not more than 30 per cent., and of clay not above 20 per cent.

In Jamaica the primitive plan of clearing forest lands by fire was largely followed, and on this cleared land ginger was grown until the soil became exhausted, when it was abandoned and a new piece of land put into cultivation. This wasteful method resulted in the production of large tracts of exhausted land, which could only be brought under cultivation once more after considerable expenditure on chemical manures. In order to avoid this objectionable way of using land, experiments were carried out by the Jamaica Agricultural Society with a view to ascertaining the most suitable manures for ginger. A mixture composed of marl, with 10 per cent. each of soluble phosphates, ammonia, and potash salts, applied at the rate of one ton per acre, gave the best results. On worn-out land a yield equivalent to 2,960 lb of ginger per acre was obtained with this manure, whilst on the unmanured, exhausted land the plants hardly grew, and gave no return.

In most parts of India manuring is regularly practised, the manures generally employed being oil-cake and dung. In some parts old and well-decayed cow-dung is either applied at the time of the first ploughing or is put in the holes made when planting the crop. During growth the ground is sometimes top-dressed with mustard-cake and castor-cake, whilst the mulch of leaves, &c., often applied to the ground after planting, also serves to enrich the soil.

The principal constituents removed from the soil by ginger are stated to be lime and phosphoric acid, and it is the replacement of these constituents which should be aimed at.

Cultivation.

In Jamaica two methods of cultivation are adopted. That by which the best ginger is obtained consists in planting in March or April portions of selected rhizomes from the previous year's crop, care being taken that each portion planted contains an "eye" (embryo stem). The land is raised into ridges and the pieces of rhizome are placed a few inches below the surface and about one foot apart, the process being much the same as that observed in planting potatoes. It is advisable thoroughly to clear the land of weeds before planting the rhizomes, as the removal of weeds become difficult later on when the ginger plants have developed. Unless the rainfall is good it is necessary to resort to irrigation, as the plants require a good supply of water. The ginger produced in the foregoing way is known as "plant ginger."

"Ratoon ginger" is obtained by leaving in the soil from year to year a portion of a rhizome containing an "eye." This "eye" develops in the normal way, giving rise to a supply of rhizomes in the succeeding season. "Ratoon ginger" is smaller and contains more fibre than "plant ginger," and the product obtained by this means is said to deteriorate steadily from year to year.

In some parts of India it is usual to plant the crop in beds about 10 to 12 ft. long and 3 or 4 ft. wide, in which the sets are placed about 9 in. to 1 ft. apart. The field is then covered over with the leaves of trees or other green manure to keep the soil moist, and over the leaves organic manure is spread to a depth of about ½ in. At the end of the rainy season it is necessary to resort to irrigation. During the first three months of the dry season the field is weeded about three times.

Before planting, the land must be thoroughly hoed (or ploughed) and harrowed, in order to produce a fine tilth. In planting large fields it would appear preferable to open up drills about 4 in. deep and 2 ft. apart, much as is done in planting potatoes on a large scale. Artificial manure, such as superphosphate and bone meal, can then be incorporated in the soil at the bottom of the drill, before planting the sets.

On account of the crop taking up such large quantities of plant food a system of rotation should be adopted if possible. This is done in some parts of Jamaica, where much of the ginger is grown in small quantities as a garden plant, in association with bananas, chillies, &c.

The method of growing ginger in the Canton district of China differs considerably from that practised in countries where dried ginger is the objective. Low-lying ground is usually selected for the crop and the cuttings are set at intervals of 6 in. in ridges about 1 ft. high and 2 ft. apart. Water is kept continously between the ridges. After the shoots have reached a height of from 6 in. to 1 ft. the plants are heavily manured at frequent intervals with urine or nightsoil mixed with water. This favours the formation of the succulent rhizome characteristic of Chinese ginger.

"Ratoon ginger" matures early, and in Jamaica is harvested from March to December; but "plant ginger" is not ready for digging until December or January, the rhizomes being gathered as they mature from that time until March. The rhizomes are known to be ready for digging when the stalks wither, this taking place shortly after the disappearance of the flowers. In Jamaica the plant flowers during September. The rhizomes are twisted

out of the ground with a fork or a hoe. In performing this operation great care is necessary, as any injury inflicted on the rhizome depreciates its market value. Considerable experience is necessary in order to lift ginger rhizomes properly.

The " hands " (complete rhizomes and adherent fibrous roots) are piled in heaps, the fibrous roots are broken off, and the soil and dirt removed immediately, as otherwise it is difficult to get the finished ginger white. The rhizomes should not be allowed to lie long in heaps, as they are liable to ferment. The usual plan is, as soon as the rootlets and excess of soil have been removed, to throw the ginger into water to be ready for " peeling " or " scraping." This is done in Jamaica by means of a special knife, consisting merely of a narrow straight blade riveted to a wooden handle; in India the outer skin is scraped off with a shell or piece of broken earthenware. In the case of Sierra Leone ginger of the ordinary grade the flat sides of the hands are scraped with a spoon and the hands are then laid out to dry without washing in water.

The operation of peeling, if carried out in a proper manner, is a very delicate one, the object being to remove the skin without destroying the cells immediately below it, since these cells contain much of the oil upon which the aroma of the best qualities of ginger depends. As the rhizomes are peeled they are thrown into water and washed; and the more carefully the washing is done the whiter will be the resulting product. As a rule the peeled " hands " are allowed to remain in water overnight. Some planters in Jamaica add a small proportion of limejuice to the wash water at this stage, at the rate of about half a pint to six or seven gallons of water, in order to produce a whiter root.

After washing, the peeled rhizomes are placed in a " barbecue," which consists merely of a piece of levelled ground covered with cement, on which the ginger is placed to dry in the sun. Where a " barbecue " is not available, a " mat," consisting of sticks driven into the ground, across which are laid boards or palm or banana leaves, is used, on which the ginger is exposed until it is dry. Uniform drying of the rhizomes is essential for the production of first-class ginger and to prevent mildew; and to ensure this they should be separately turned over by hand at least once on the first day. Careful planters put their ginger out daily at sunrise, and take it in each night at sundown; conducted in the latter way the operation of drying usually takes from six to eight days. The ginger, if not sufficiently white in appearance, has to be bleached by further washing, and after being re-dried is ready to be packed for export. In some parts of India the peeled rhizomes are bleached by soaking in lime-water for a short time and exposing them for about 12 hours after drying to the fumes of burning sulphur in a specially constructed bleaching-room, at the rate of 7 lb of sulphur per ton of rhizomes.

The finished ginger is graded according to size and colour of the " hands " —the best grades consisting of the large plump " hands " free from traces of mildew, and the poorest shrivelled, dark-coloured " hands." As a rule the crop is divided into four or five grades. The best " hands " obtained in Jamaica weigh as much as 8 oz., 4 oz. being an average weight.

Unpeeled ginger is merely freed from its rootlets and excess of soil, and then thoroughly washed in water or scalded in a boiler of hot water, and finally dried in the sun

Preparation of Preserved Ginger.—In China the first crop of ginger is ready about three months after planting. This is known as " young ginger " and is the least pungent and most expensive. Unlike the Jamaica and

Indian ginger, the rhizomes are not allowed to mature, as they become too pungent for the purpose for which they are required. After harvesting the roots are washed and the skin carefully scrapped off. They are then punctured by means of a fork and afterwards washed in rice water (the water left after washing rice) to improve the colour. The rhizomes are next boiled in three or four changes of refined sugar and water for one or two hours, until thoroughly soaked. They are then placed in barrels or other containers and covered with syrup. In the case of dry preserved ginger, the wet rhizomes are strained till dry and then rolled in sugar placed on bamboo matting.

Yield.

The yield of ginger varies considerably with the climate, soil, and methods of cultivation employed. In Jamaica the average return is from 1,000 to 1,500 lb of dried ginger per acre, but as much as 2,000 lb per acre has been obtained under the best conditions. The recorded yields in different parts of India vary within wide limits. In Bengal it is stated that 1,000 to 1,5000 lb per acre is the average crop, in the Punjab 2,100 lb, in Travancore 2,000 to 2,500 lb, whilst in an experimental cultivation at Surat, Bombay Presidency, the yield was equivalent to over 8,000 lb per acre. As already mentioned, a yield equivalent to nearly 3,000 lb per acre was obtained in Jamaica on exhausted land by the application of a suitable manure; and there is no doubt that, by careful cultivation and manuring, the yield in all the countries mentioned could be considerably increased. It takes about 4 tons of fresh dug rhizomes to give 1 ton of dried ginger.

Pests and Diseases.

Owing to the pungent nature of the shoots. the ginger plant is attacked by very few insect pests, and it has even been recommended that the crop should be planted in orchards to prevent the development of pests of fruit trees. At the Rangpur Agricultural Station, Bengal, however, the larva of a Drosophelid fly, which lives on coarse grasses, has been observed to do a good deal of harm to the shoots.

In Southern India the caterpillar of a butterfly, *Udaspes folus*, sometimes does great damage to the leaves, whilst the caterpillar of a moth, *Diccho-crocis punctiferalis*, bores into the stem and rhizome, but seldom does serious harm. The latter is better known as a pest of castor plant in Southern India. In Travancore the rhizome is bored by the larva of a small fly (*calabota* sp.) which deposits its eggs at the base of the plants; when the crop is gathered the larva migrates to wild arrowroot, where it completes its development. The best remedy is stated to be the destruction of the alternative food plant.

The coconut scale, *Aspidiotus destructor*, has been found to occur on ginger in Fiji, but no information appears to be on record as to the extent of the damage caused.

Considerable injury is inflicted on ginger crops in Jamaica by a disease called "black rot," which attacks the underground parts of the plant, and brings about decay of the rhizomes. The first indication of the disease is a yellowing of the leaves, which droop and wither; the bases of the stems become discoloured and rot, and finally decay spreads to the rhizomes, which disintegrate to form a putrefying mass of tissue. A fungus present in the decomposing rhizomes was found to form spores in a similar manner to *Allantospora radicicola*, Wakker, a fungus which causes a root disease of sugar-cane in Java. It was not clearly shown, however, that the fungus found in the old rhizome was the cause of the disease (Howard, *Bull, Bot. Dept., Jamaica*, 1901, **8**. 181; 1902, **9**, 42).

A similar rot of the rhizome, caused by a species of Pythium, which occurs in India, was first recorded by Butler from Surat and is described by McRae in *Agri. Journ., India* (1911, **6**, 139). The disease spreads rapidly through the soil, and to prevent infection of healthy plants every portion of an affected plant must be removed and burnt, whilst the soil itself should be treated with lime, or a light dressing of sulphate of iron may be applied. Isolation of infested soil by a trench has been tried with success, but in the case of a bad attack ginger should not be grown on the land for at least three years. The disease is most serious on wet, heavy soils or in exceptionally rainy seasons, and it may be prevented to a large extent by draining the land, so that no water lies round the collar of the plant. Great care should be exercised in selecting only healthy rhizomes for planting purposes, any plants with even the slightest trace of disease being rejected. After a bad attack it is advisable to steep the rhizomes for about half an hour in Bordeaux mixture before planting, to destroy any fungus spores or hyphæ on their surface or in the soil clinging to them. The fungus, which also occurs on tobacco and papaya in India, was at first thought to be *Pythium gracile*, Schenk, which in Europe is found on freshwater algæ. Subramaniam, however, showed that it is a distinct species, which he calls *Pythium Butleri* (*Mem. Dept. Agri., India, Bot. Ser.*, 1919, **10**, 181).

Another disease of ginger which does some damage in Jamaica is locally called "cork rot.' This cannot be detected until the crop is gathered, when the rhizomes are found to be of cork-like texture and quite valueless. The exact nature of this disease does not appear to have been investigated.

A new disease of ginger, caused by *Vermicularia Zingiberæ* and reported from the Godaveri District, is described by Sundararaman in *Mem. Agri. Journ., India, Bot. Ser.* (1922, 11, 209). The disease begins with small yellowish spots and later the whole leaf turns yellow and rots, resulting in a poor development of the rhizome. It makes rapid progress during a period of continued wet weather and high humidity, but the advent of drier conditions checks its growth and the plant may recover. Spraying with Bordeaux mixture was found to be effective against the disease.

USES OF GINGER.

For flavouring purposes ginger is perhaps the most widely used of all spices. It is employed whole in the preparation of various confections, chutneys, pickles and the like, and in the ground condition for a great variety of purposes. Large quantities are used in the manufacture of ginger beer, ginger ale and similar beverages. Its medicinal value is well known, the root being used chiefly as a stomachic and internal stimulant, especially in flatulency and colic. The pungency of ginger is due to the presence of a resinous substance and the odour to an essential oil. The latter is separated by steam distillation and used to some extent in perfumery. The characters of the oil are dealt with in this *Bulletin* (pp. 651,654) in connection with reports on a sample of ginger peelings from Sierra Leone and on a sample of the oil received from Seychelles.

In connection with the attempts being made to improve the quality of Sierra Leone ginger, the Imperial Institute recently made inquiries regarding the uses of the various types of ginger, the results of which may be here summarised.

Unscraped (unpeeled) ginger is used as a cheap substitute for peeled ginger for most of the purposes for which the latter is usually employed. When peeled ginger is relatively cheap less unscraped ginger is used in this way whilst, on the other hand, more of it is used when peeled ginger con-

mands a high price. A certain amount of unscraped ginger is also employed by distillers in the United Kingdom, who prefer it to peeled or scraped ginger, because it contains rather more essential oil. In the latter connection it was considered that the peelings might also find a market amongst distillers, and a sample was obtained from Sierra Leone for investigation at the Imperial Institute, the results of which are given on page 650 of this *Bulletin*.

For certain purposes only peeled ginger is suitable, *e.g.* for the "whole ginger" sold by grocers, for the best grades of ground ginger and for the best kinds of ginger beer. Unscraped ginger is sometimes used for the lower qualities of ground ginger, but not commonly for ginger beer. For medicinal use, "scraped" ginger alone is official in the British Pharmacopœia, but both peeled and unpeeled may be used for official preparations in the United States.

Ginger from no one country is in demand exclusively for any particular purpose. The peeled ginger from Jamaica, Cochin and Japan is all used for the same purposes, the grade of ginger employed depending on the quality of the article to be produced. Unscraped varieties from different sources are generally interchangeable.

From *Bulletin of the Imperial Institute* (1926) 1927

CULTIVATION OF PINEAPPLES.*

By D. H. Grist, Agricultural Economist.

Hawaii and Malaya are the world's main centres for the production and canning of pineapples. The estimated area in bearing in Hawaii is 50,000 acres; while Malaya has a total of about 50,000 acres, 42,000 acres of which are situated in the State of Johore, and 8,000 acres on Singapore Island. Pineapple canning is also carried on to a lesser extent in South Africa (centred at Port Elizabeth), in Formosa and in parts of Australia.

The following account is a comparison of the systems of cultivation and the conditions obtaining in Malaya, Hawaii and South Africa.

Climate.

The climatic conditions in these three countries of production vary considerably. The following table shows the average rainfall and temperature.

Country.	Average rainfall. inches.	Average mean shade temperature.
Malaya (Johore)	89·09	80·0 F.
Hawaii (Honolulu)	31·60	74·6
South Africa (Port Elizabeth)	22·51	63·6

In Hawaii, the precipitation is heavier from November to March inclusive, but in South Africa the rainfall is fairly evenly distributed throughout the year. The rainfall in Johore is somewhat erratic; the rainy months are generally December to March, but there is usually an ample rainfall each month.

* The following account is compiled from information obtained over a number of years by officers of the Department of Agriculture S.S. & F.M.S. regarding Malayan pineapple cultivation; *Notes on the Pineapple Industry in Hawaii* supplied to the Director of Agriculture from a private source; and *The Pineapple Industry in South Africa* from a report by Mr. C. A. O'Conner of the Mauritius Department of Agriculture. Reference has been made to *Notes in Pineapple Cultivation* appearing in *The Tropical Agriculturist*, Vol. LXX, No. 1, January, 1928, and to *Growing and Canning Pineapple in the Hawaiian Islands*, in *Dun's International Review*, April, 1928.

The above figures demonstrate that pineapples will flourish within wide ranges of climate in the tropics or sub-tropics, but the system of cultivation must vary between these countries to adapt the crop to local climatic conditions.

SOILS.

Pineapples will grow on a wide range of soils, but favour the heavier types of soil with good soil aeration and drainage. The soils of Hawaii are of volcanic origin and rich in mineral plant foods. In Malaya, the crop thrives best on the stiff clay types of soil. A rich soil is held to be unsuitable as it tends to develop the size of fruit at the expense of flavour. It is for this reason that the fruit produced on the poorest of the Singapore lands have the best flavour when canned. It is probable that with a rich soil, growth is more rapid in Malaya than in either Hawaii or South Africa with their lower rainfall and temperature.

VARIETIES.

The two main varieties used in canning are the "Smooth Cayenne," a large pineapple with small "eyes," weighing about 5 to 6 lb and the "Queen" type, a smaller pineapple, with deeper and rather irregular eyes weighing about 3 to 5 lb. Opinions differ regarding the relative merits of these two varieties for canning purposes. It is held in Hawaii and South Africa—which have adopted the "Smooth Cayenne"—that the flavour of that variety is superior to that of the "Queen" types. In Malaya, the latter variety is used exclusively for canning as it is held to have a better flavour and to be more suitable for canning. Here again, it is possible that climatic and soil condition may be responsible for these differences of opinion, which, of course, are based on the experiences of the canners. The "Queen" type has two advantages of some importance—it is hardier, and it produces a greater number of "suckers" than does the "Smooth Cayenne," a matter of some importance in replacing or extending areas under the crop.

PRELIMINARY CULTIVATION.

The fundamental differences in system of cultivation between these three countries is that whereas in Hawaii and South Africa pineapples are treated as a sole crop, in Malaya they are almost invariably planted as a catch crop; generally in conjunction with Para rubber as the permanent crop.

In each case, it is realised that pineapples cannot be grown indefinitely on the same land: the land must either be rested after a number of years or it must be utilised for alternative crops after carrying pineapples for some years. The Hawaiian rich soils vary considerably; in some cases they produce fruit for three or four years, after which resting for one or more years is necessary; in other instances they are still bearing well after fifteen years. It is reported that many of the soils, however, are finished for pines after eight years. In Malaya, virgin soil is generally used for pineapple cultivation. The pineapples are planted directly the heavy jungle is felled, burnt and cleared. The plants commence to fruit in from 12 to 18 months, and will continue to fruit until the fifth to sixth year, by which time the fruits produced are small. The rubber which forms the main crop has also become a tree of considerable size, so that further cultivation of pineapples is out of the question.

Much of the Hawaiian pineapple land was formerly pasture land, but newer areas, in many cases, had to be cleared of cactus and rocks. It was never jungle and the islands are not thickly wooded. Abandoned land reverts to pasturage.

The South Africa pineapple land has to be cleared of bushes and grass.

Both in South Africa and Hawaii, the preliminary cleaning of the land is followed by a thorough cultivation of the soil. In the latter country, 95 per cent. of the land is cultivated with caterpillar tractors, steam ploughing equipment never being employed. As mentioned previously, in Malaya the land receives no cultivation before planting the pineapple plants.

PLANTING.

Pineapple planting material is of four descriptions: viz., ratoons, which are formed from buds on the stem among the roots; "suckers," formed in the leaf axils; slips, formed from buds appearing immediately below the fruit; and crown slips and crowns, formed from buds beneath and around the crown of the fruit. Ratoons and suckers are the most suitable for planting purposes, as they produce fruit earlier than do the less strongly developed slips, which are very small and should first be planted in a nursery to develop a strong root system. The effect of planting material and climate may be seen from the following comparison of the length of time taken for the plants to reach the bearing stages:—

Country.	*Crowns.*	*Suckers.*
Malaya	18 months	12 months
Hawaii	20 months	14—16 months
South Africa	2 to 2½ years.	

Considerable variation exists with planting distances employed in different countries. The usual Malayan system is to space the plants 5 ft. by 2½ ft., with a six foot path at every 100 feet. This spacing gives from 3,000 to 3,400 plants per acre. In Hawaii, it is customary to plant very close, 9,000 to 12,000 plants per acre, with a tendency towards an even denser population of plants. Slips or suckers are usually planted in double rows, 12 to 18 inches between plants in the row, 16 to 24 inches between rows. The distance between the centre of this double row and the centre of the next double row is about 6½ feet.

The South African practice is to plant in double rows, the plants being two feet in the row and two feet apart between rows; a space of five feet is left between the double rows. In this system there result about 6,300 plants per acre.

Suckers and ratoons for planting are cut square at the base, the lower leaves removed and frequently dried in the sun for a while before being planted. In some quarters it is held that there is no advantage in the preliminary drying, but it appears to be the usual practice both in Malaya and Hawaii.

The plants should be placed from three to four inches deep in the ground—the actual depth depending upon the size of the plant. Care must be taken that no soil or sand enters the bud as it will kill the plant, or at least retard its development.

CULTIVATION.

After planting, the fields require weeding, but apart from such attention no further cultivation is given in Malaya. In the other countries of production, however, the low rainfall renders it necessary to do everything possible to conserve the moisture in the soil. The usual method of frequent surface cultivation achieves this object, but in Hawaii, exceptional measures are taken, partly at least towards this end. The fields are mulched, with an asphalt-treated paper so spread as to provide spaces necessary for cultivation and harvesting. It is claimed that this mulch (under the commercial name of "Pabco") reduces weeding costs, conserves heat and moisture;

and so increase yields as to render it a financial success. The " Pabco " is first spread—sometimes by a machine which lays it flat, turns down the edges and kicks up earth to keep it down—and the plants placed in holes made in it with a trowel. The disadvantage mentioned against the " Pabco" mulch is that it forms a breeding ground for pests. This mulch is widely used in Hawaii. Owing to the heavy rainfall, it would not have the same advantages in Malaya. Pineapple land is ploughed four or five times a year on African plantations, the ploughing being done with oxen.

Mention must here be made of a peculiar feature in pineapple planting in Malaya. The great majority of the areas under this crop are owned by Chinese, who, in many cases, are the owners of the factories. The Chinese owner of land which he wishes developed with pineapples and rubber makes an arrangement with a number of Chinese squatters to plant up his land with pineapples and to keep it clean for an agreed charge per month per acre. Each squatter is thus definitely and absolutely responsible for a portion of the estate, and generally erects his own temporary abode thereon. The agreement provides that a squatter shall get 50 per cent. of the value of the pineapples as a bonus, after cartage costs have been deducted and the agreement usually contains a clause which provides for the payment to the squatter of a certain sum per acre for cleaning the pines off the land after five years. In one typical instance, the agreement provided for the payment to the squatter of $1 an acre a month to cover the full cost of planting and weeding, a bonus of 50 per cent. of the value of pineapples after deduction of cartage costs, and the payment by the owner of $8 per acre for cleaning off land and burning the pineapple plants at the completion of the agreement.

Such complicated methods of management are possible between Chinese and Chinese, but are impossible between European and Chinese.

The usual Malayan contract rates are around $7 per acre for planting; and for weeding and earthing up plants, $2.50 per acre per mensem.

In Hawaii, the land is manured just before planting, and a further application is sometimes given before the plants commence to bear fruit.

It is difficult to obtain data of the labour requirements for cultivation, but some idea of the probable cost can be obtained from the requirements of an Hawaiian plantation. An estate of three or four thousand acres is run by one man. Under him are Japanese conductors, one for every 1,000 acres. They will have under them ten heads of coolie gangs, each of which would be in charge of about ten coolies at the height of the season. Salaries: Manager, about $1,000 per month; Divisional Manager, $550; Conductor, $90; all sharing in profits.

The permanent labour force is about 60 men per 1,000 acres, a number which is in excess of requirements in the slack season. This number may be increased to over 100 men per 1,000 acres during the busy season. Formerly, the labour force was mainly Japanese, but owing to restriction on Japanese immigration, they have now been largely replaced by Filipinos.

YIELDS.

In Malaya, there are two main crops per annum, the first in May and June and the second in November and December, but the plantations are producing fruit throughout the year. During the first year of fruiting the plant will produce one fruit, but in subsequent years, two fruits per plant are usually obtained. The average annual yield is between 4,000 and 5,000 fruits per acre per annum.

Although there is fruit being obtained throughout the year, the main Hawaiian harvest, June to August produces the heaviest crops, with a second

crop in December to February. When the first crop is obtained—one fruit per plant—all suckers, with the exception of two, are removed; as a rule, no further removal of ratoon are made unless they are required for planting purposes. The Hawaiian plantations, by reason of close planting, the application of manures and cultivation, produce heavier crops than are obtained in Malaya. In South Africa, the annual crop is estimated at between 6,000 and 10,000 fruits. Although the yields of pineapples from Malaya are small, it must be remembered that the capital invested is also smaller than with other countries, and that the land is planted with a second crop—rubber.

An estimate of the cost of bringing an acre of pineapples into bearing in Hawaii has been stated as follows (currency, dollars gold).

Clearing, $40; ploughing, $25; plants, $56; planting, $10; weeding and ploughing, $27; fertilising, $35; harvesting, $13.50; collecting, $36; total, $242.50.

It must be understood that subsequent crops will cost very much less; the only fair way of arriving at cost being to average it over a period of not less than four years.

In a subsequent number of *The Malayan Agricultural Journal* it is proposed to conclude this series of articles on pineapples by a consideration of the subject of pineapple canning.

PIGS AND PIG PRODUCTS.

TWELFTH REPORT OF IMPERIAL ECONOMIC COMMITTEE.

RECENTLY published by the Imperial Economic Committee is a very interesting and valuable report entitled *Pigs and Pig Products*. The report deals with the marketing and preparation for market of pigs and pig products within the Empire and in those countries from which pig products are imported into Great Britain.

2. Much of the report, particularly that dealing with manufactured products and markets overseas, is of no economic interest to pig raisers in Fiji in the present state of our development and will not be considered in this review which will be confined to those parts dealing with such features of the industry as breeds and types, feeding, housing, association with dairying, grading, &c.

3. The following is a brief resumé of the points raised in which Fiji may be interested:—

Breeds.—White breeds are not popular in most tropical countries. These breeds are, however, very popular amongst the importing countries. Other popular breeds in the Empire are Berkshire, Tamworth, Gloucester Old Spot and others. The report, h wever, is unfavourable to a multiplicity of breeds, as such a condition is not conducive to the production of a uniform type so desired by the manufacturers and pork butchers.

Feeding.—The report emphasises the importance of an abundance of cheap food in pig raising areas. The areas raising the greatest proportion of pigs are those in which the chief products are maize, potatoes and dairy products. In U.S.A. five states, forming the centre of the maize belt produce two-fifths of the total number of pigs in that country. Other important foods are barley and other hard grains. The type of pig produced varies with the

food materials. Those fed chiefly upon potatoes or maize are of the very fat type, whilst those whose ration consists of milk products and hard grain are of the lean, very firm type.

Housing.—This question is not dealt with at much length by the report, but nevertheless is a subject of great importance. Housing requirements will vary depending on the climatic conditions.

Association of pig-breeding industry with dairying.—The necessity of establishing the pig-raising industry in connection with dairying is emphatically stressed. It is pointed out that the raising of pigs on the by-products of dairying is the most profitable method of disposing of such products. Denmark's example in this respect is pointed out, and attention is drawn to the suitability of New Zealand for pig-raising on account of its extensive dairying industry.

Marketing.—The keystone of this discussion is the necessity of co-operation among all persons interested in the pig-raising industry. First and foremost the consumers' needs must be satisfied, and to accomplish this, understanding must exist between breeders, agents, butchers and other people concerned in the trade. Each breeder should endeavour to maintain a regular supply, and organisation should exist amongst breeders to prevent over-production and to ensure a regular supply.

Pig-raising on closer settlement areas.—The report raises the point that pig-keeping plays or should play an important part in closer settlement. In Denmark one-third of the pigs are raised on farms of less than 37 acres and seven-eighths on farms of less than 150 acres.

THE PIG AND PIG PRODUCTS REPORT AS IT APPLIES TO FIJI.

By H. M. Stuchbery, B.V.Sc.

Elsewhere in this *Journal* will be found a review of the report on pigs and pig products by the Imperial Economic Committee. This report contains much that is of interest to those associated with the industry in Fiji, and much valuable information may be gleaned from its pages.

2. The question of breeds is interesting. It will be noted that the white breeds are not popular in other tropical countries, but it cannot be said that these breeds do not thrive in Fiji provided they receive reasonable treatment. Certainly those kept in sties or having access to suitable shelter do quite well. Possibly, were they allowed to run at large without shelter from the tropical sun's rays they would not do as well as the other breeds, but this state of affairs is not usual in Fiji where abundance of shade is usually to be found. The coloured breeds such as the Berkshire and Tamworth do very well in Fiji.

3. Of the food sources mentioned in the report, the only ones common to Fiji are maize and dairy by-products. We have however, many foods here eminently suitable, such as rice-bran, coconut meal, bananas and various roots such as kumalas. Most of these could be produced very cheaply, much more so in fact than food-products used in other countries for pig-raising.

4. The question of pig-raising in association with dairying is an important one to Fiji. At present we are not making sufficient use of dairy by-products such as skim milk. By the feeding of these to pigs a much bigger revenue could be derived from dairy farms at little extra cost. In addition

to this, other good pig-foods could be obtained quite close to our dairying areas at a very reasonable cost. When the Tailevu road is completed all the dairying centres will be within easy reach of the main Suva market.

5. Suitable housing for pigs is most important in Fiji. The presence of parasites, particularly the kidney worm (*Stephanurus dentatus*), has to be considered, and methods of control adopted. Dirty and badly drained sties make ideal conditions for the spread of these parasites. On the other hand, these parasites spread with equal facility in damp low-lying, pastures or those with " wallow-holes " on them. Pig-sties should, therefore, be well drained, and capable of being cleaned and disinfected easily. As well as this, pastures should be dry and also be changed frequently.

6. Methods of marketing in Fiji, where there is only a local market to be supplied, will necessarily differ from those in other countries catering for both home and export markets. However, the principles of co-operation and understanding between each section concerned in the trade is just as important as is also the regular supply of pigs of a uniform type. At the present time, for the Suva market, the demand for pigs for slaughter is limited to about 80 animals a month. It would be necessary for breeders to keep their monthly supplies at this figure in order that there should be no over-production. There is, however, throughout the Colony, a considerable consumption of pig meat, whilst in the vicinity of Suva, a considerable amount is consumed by Chinese, Fijians and others, which is not included in these figures.

7. Profitable pig-raising appears to go hand in hand with closer settlement in agricultural and dairying communities. It is a fairly regular practice in other parts of the Empire, for the majority of farmers on closer settlement areas to indulge in pig-breeding to a greater or less extent. In Fiji we have many such areas eminently suitable for pig-breeding. The chief drawbacks at present are a lack of market for the animals if the industry was developed extensively, and the lack of knowledge on the part of settlers, of the principles of pig-breeding. It is probable, however, that the demand for pork and bacon will increase as time goes on and supplies will have to be increased.

8. There is an art in pig-raising and some skill is required. All farmers will not be successful but there would appear to be no reason why the industry should not be immediately developed by those adapted for it to meet at least our local requirements.

THE SECOND IMPERIAL MYCOLOGICAL CONFERENCE.

Report by J. G. C. Campbell, B.Sc., Government Mycologist.

I have the honour to submit the following report on my attendance, as representative of Fiji, at the Second Imperial Mycological Conference, held held in London 23rd to 28th September, 1929.

2. On 16th September I received a letter from the Colonial Office informing me that it was the wish of the Secretary of State that I should comply with the desire of the Acting Governor of Fiji and attend the Conference as representative of the Fiji Government.

3. The Official Report (Colonial No. 45) gives a very full summary of the proceedings of the Conference so that, in my own Report, I have considered it necessary only to collect together and comment on those sections which, I think, are of direct interest to Fiji.

4. Most of the contributors to the discussions dealt with the diseases of temperate crops; on the whole, tropical crops, and especially those of interest to Fiji, received only passing mention.

5. A great part of the time was devoted to the consideration of the administrative side of Plant Protection Services. I have attempted to summarise the opinions which were put forward by various speakers and accepted by the Conference.

6. The basic assumption is that every country, and particularly every tropical country is entitled to take whatever measures it considers necessary for the protection of its crops.

7. The object of regulations shall be to control the movement of plant material into the country so that the possibility of introducing disease or pest is reduced to a minimum. In formulating such regulations consideration must be given to the economic effects of their introduction, *e.g.*, restriction of food plants would be impracticable. Consideration should also be shown to exporting countries which the regulations will effect and, in some cases, it might be advisable to obtain the views of particular exporters in those countries. The result might be the avoidance of unpleasantness and inconvenience by the imposition of unnecessarily strict restrictions.

8. A necessary preliminary to the formulation of regulations to protect any crop is a thorough knowledge of the habits of causal organism and a knowledge of the geographical distribution of the diseases.

The Conference expressed its appreciation of this fact in Resolution No. 6*. It was suggested that the Imperial Bureau of Mycology should issue lists or maps indicating the distribution of the more serious diseases of imported crops.

9. In order to keep the knowledge of disease distribution up to date, it was considered essential that each country should publish a list of the diseases with which they were afflicted and should promptly notify any change in the general plant disease situation or the appearance of any new disease.

It was suggested that some scheme of co-operation might be arranged on the following lines:—

(*a*) *Group notification.*—Countries geographically situated so that the transference of disease from one country to another was a potential danger should notify one another directly of any change in the plant disease situation.

These countries might also come to some agreement among themselves as to the treatment of any plant materials exchanged between them (Resolution No. 8).*

(*b*) All countries should notify any change in the plant disease situation to the Imperial Bureau of Mycology which would publish the information in the *Review of Applied Mycology* for general information, or, if necessary, inform interested countries directly.

(*c*) All new regulations, alterations or amendments should be promptly notified to group countries and to the Bureau of Mycology for general information.

For the information of Delegates attending the Conference, the Bureau of Mycology drew up a summary of the plant protection regulations in the Dominions and Colonies. This interesting document* is attached to this report.

10. Regulations to restrict the importation of diseased material should be based on the following principles:—

* Not printed.

(*a*) The importation of plants susceptible to the disease against which the regulations are directed may be prohibited either entirely, or from certain countries. Alternatively, they may be imported only with the permission of the agricultural authority who will decide in each case whether importation may safely be permitted, and under what conditions.

A number of delegates considered that total prohibition was the only safe method. It was generally agreed that the success of total prohibition would depend on the geographical situation of the country, the efficiency of the plant protection service and in general, the effectiveness with which the illegal importation of plants could be controlled.

(*b*) The plant material should be restricted to that necessary for propagation, should be imported only with the consent of the agricultural authority and should be retained under strict official quarantine untill such time that it can be definitely decided that it is not affected with any disease.

This is the method which should be observed for the introduction of new stocks of a staple crop. Its success depends on the rigid observance of quarantine.

After discussion on this matter, the Conference passed Resolution No. 3.*

(*c*) Plant material may be admitted after being treated in some approved manner to render it inocuous. It was generally considered that, as far as fungal diseases and especially diseases due to filtrable viruses were concerned, this method would be most unreliable. Under certain conditions, it might be workable, but as a general principle, it was bad.

(*d*) The fact that a disease is already present in the country is not necessarily a justification for permitting the unrestricted entry of material infected with the same disease. The danger to be guarded against is the introduction of a new biological strain which might prove much more destructive than the strain already present. This has been exemplified particularly in the case of the rusts of cereals.

(*e*) Under certain conditions, the importation of infected material may be permitted if the disease concerned is not likely to endanger staple crops. This applies particularly to the importation of food plants. It should, however, be avoided if possible.

11. Much consideration was given to this matter of certificates to accompany imported and exported plant materials. This resulted in the adoption of Resolutions Nos. 7 and 7 (*a*).*

12. It was considered that a certificate should not be regarded merely as a guarantee of quality. It should be rather a document giving as much information as possible about the health of the consignment. A certificate should be given and accepted on this understanding.

13. It was unanimously agreed that it was a practical impossibility for the Mycologist, or any other officer, to certify, from inspection alone, that any particular consignment was free from disease.

14. It was considered that inspection of the crop in the field was of considerable importance in determining the freedom from disease of a consignment. It was considered essential where seed stock was concerned.

15. It was considered desirable that, if possible, some standard form of certificate should be adopted for use between countries of the British Empire. The certificate given in Appendix 1A of the Conference Report was adopted as a working basis, the intention being that it was to be circulated to the

* Not printed.

various Governments concerned for criticism. The following were the points emphasised:—

(*a*) The examination should be made as near as possible to the time of shipment, the exact time being noted on the certificate.

(*b*) A representative sample of the shipment should be examined.

(*c*) If possible the crop should have been examined in the field; this examination or its omission should be noted.

(*d*) The place where the crop was grown should be noted, this being considered to be of more importance than the place of export.

(*e*) A certificate of absolute freedom from disease is not required, but any disease or pest observed should be noted, whether specified in regulations or not. Where a special examination is made for any particular disease, this should be specifically noted.

(*f*) Any treatment to which the consignment has been submitted should be noted.

16. It was to be distinctly understood that the acceptance of this or any other certificate did not prevent the importing country from exercising its right to prohibit, quarantine, treat or otherwise deal with the consignment.

17. Regulation should be framed in such a way as to deal with any emergency that might arise, *e.g.*, the prevention of the entry of a diseased consignment should not be made impossible because the disease concerned is not included in some schedule.

18. A little discussion took place on the internal control of plant diseases. Delegates from tropical countries agreed that most of their difficulties arose out of ignorance, lack of interest and absence of co-operation on the part of the planters—in most cases, natives. The primitive methods of cultivation—or lack of any method—were also considered to contribute towards the difficulties encountered. It was agreed that education of the planters by means of travelling instructors was the best means of combatting disease and that police methods were, on the whole, quite useless.

19. It was concluded that it was not desirable, nor, in fact, practicable to formulate standard regulations for general adoption. Each country must make its own arrangements, giving due consideration to the principles previously outlined, but it was thought that co-operation between countries which exchange plant products was highly desirable for the harmonious working of their respective plant protection services.

20. Mention was made of the grading of plant products. It was suggested that some standardisation of grading was necessary and that consideration should be given to the disease carrying potentialities of produce especially in connection with seed stock.

21. Continuing with other subjects dealt with by the Conference, the diseases of fruit shipped Overseas formed the subject for discussion at one of the meetings. Although most of the references were to the troubles experienced in the shipment of apples to England, and the work of the Low Temperature Research Station, a few references were made to the transport of bananas. These are given, though it is not considered that they add to the knowledge which we already possess.

22. Mr. Smith of Jamaica outlined the method of shipping fruit from the West Indies. The only variety shipped to any extent was the Gross Michel. The entire shipping was done by the Fruit Company and not by individual growers; this greatly simplified matters. The fruit was carefully graded, the particular grade sent depending on the destination. Thus, the less

mature fruit would be sent to Europe and the United Kingdom, more mature to New York and so on. The grades, which are selected so that the fruit will be ripening on arrival at its destination are:—

(*a*) " bursting full," *i.e.*, almost ripe;
(*b*) " found full ";
(*c*) " Full three-quarter " in which the fruit is still ridged;
(*d*) " Three-quarter."

The fruit is shipped in bunches of 6, 7, 8 or 9 hands. The grading and general condition of the fruit is checked frequently until loaded. Bunches are packed so as to give the maximum amount of ventilation. After loading, the hold is immediately cooled, the temperature being reduced to 52–55 degrees Fahrenheit in 3–3½ days by circulating cold air. The result is that very little transport trouble occurs. *Gleosporium* ripe rot is sometimes seen and occasionally a stem end rot associated with *Thielaviopsis*.

Cavendish bananas, if shipped, must be very carefully packed because they are much more readily damaged than the Gros Michel. Trouble is sometimes experienced with a rot associated with *Gleosporium* and connected with the persistence of the style in this variety. The Red Banana is shipped in the same way as the Gros Michel. Other varieties are not shipped as they ripen too rapidly.

23. Dr. Reichert described the following diseases of Cavendish bananas in Palestine:—

(*a*) Tip End Rot caused by *Macrophoma musarum*;
(*b*) Cigar End Rot caused by *Fusarium sp.*;
(*c*) Steam End Rot, commencing at the stem end of the fruit, and associated with *Fusarium sp.* This condition appears to be identical with " Black End " of Fiji;
(*d*) Rots caused by *Botrytis* and *Sclerotium*;
(*e*) Rot of the entire fruit caused by a *Diplodia* and found only in fruit growing among organges which are frequently affected with *Diplodia*.

24. According to Mr. Tomkins of the Low Temperature Research Station, much loss was experienced from rot due to *Thielaviopsis* in pineapples from the Azores.

25. On the subject of the Control of Insect Pests by means of Entomogeneous Fungi, the speakers were agreed that there was very little hope of securing economic control of insects by this means.

26. A paper was read by Mr. Bunting on the Deterioration of Produce by Moulds. I was unfortunately unable to attend the Conference on this occasion, but Mr. Bunting informed me that it was the intention of the Stored Products Investigation Station with which he was associated, to investigate the problem of the deterioration of copra by moulds. Mr. Bunting expressed his willingness to consider Fijian copra in his investigations and it is my intention to visit the Station at Slough, before my return to Fiji, to see if it will be possible to arrange with him some co-operative scheme.

27. The last matter which I think is of interest to Fiji is that mentioned in Resolution No. 2* on the provision of handbooks on the diseases of tropical countries. There are no adequate books on tropical diseases as there are for the diseases of temperate climates. The proposal is to supply this deficiency by means of a series of books published under the general editor-

* Not printed.

ship of the Bureau of Mycology and compiled by specialists on the various diseases. The volumes which would be of particular interest to Fiji are those on Cotton, Coconuts, Bananas and other Fruits, Cereals and Rice and Ground Provisions (which covers native food-stuffs, &c.)

Should Fiji be approached as suggested in para. 8 of the Committee's report, I would recommend the project to the Government for favourable consideration.

28. In conclusion I have only to add that I voted affirmatively to all the resolutions submitted to and adopted by the Conference.

PRESERVATION OF TIMBER.

References to these papers are to be found in: Ind. Engng. Chem., xxi, no. 7, pp. 705-709, July 1929.

The following notes have been forwarded by Dr. J. D. Tothill, Director of Agriculture, Uganda:—

Papers have appeared recently in the *Journal of Industrial and Engineering Chemistry* on the subject of a new wood preservative said to be superior to Creosote. The method consists in soaking the air-dry timber in a solution containing the following materials:—

	Per cent.
Sulphuric acid	0·30
Zinc sulphate	3·00
Calcium acetate	2·10
Caustic Soda	0·75
Arsenic	2·25

After soaking, the timber is air dried and is then ready for use.

The note discussing this method states that—

"In January, 1928, the U.S. Department of Agriculture installed "a number of zinc meta-arsenite treated yellow pine posts on Barro "Colorado Island, Panama Canal. When officially inspected in Feb- "ruary, 1929, they were in perfect condition showing no decay and "*no attack by white ants*. Untreated yellow pine posts set at the same "time were completely destroyed. There are 36 species of tropical "termites on the island and the annual rainfall is about 130 inches."

SUBSIDIES FOR IMPORTATION OF LIVE STOCK.

IMPORTATION OF PEDIGREE AND GRADE CATTLE.

GOVERNMENT SUBSIDIES.

At the meeting of the Legislative Council in May, 1930, approval was given for the increase of the subsidy on imported pedigree cattle and horses from £7 per head to £10 per head and of the payment of a subsidy of £5 per head on grade cattle of good quality. The rules governing the payment of subsidies are set out below:—

RULES REGARDING SUBSIDIES PAYABLE IN RESPECT OF IMPORTATION OF CERTAIN LIVE STOCK.

2.—(1) *Pedigree Cattle and Horses.*—A subsidy of £10 per head will be paid for each registered pedigree animal capable of breeding brought into the Colony. The subsidy will apply only to cattle which have attained the age of nine months and have not attained the age of five years and horses which have attained the age of nine months and have not attained the age

of eight years. An animal imported under the age of nine months, if otherwise qualified, shall be eligible for the subsidy on attaining the age of nine months.

Grade Cattle.—A subsidy of £5 per head will be paid for each female animal which has been registered, in the country from which it has been imported, as being the progeny of a registered pedigree sire and a dam which has been credited, by a Herd Testing Association, with having produced in one lactation period, the following amounts of butter fat (or over) according to age at the commencement of the test, viz.:—

as a 2 year old, 250 lb butter fat,
as a 3 year old, 275 lb butter fat,
as a 4 year old or older, 300 lb butter fat.

The subsidy will apply only to animals which have attained the age of nine months and have not attained the age of five years. An animal imported under the age of nine months, if otherwise qualified, shall be eligible for the subsidy on attaining the age of nine months.

(2) An animal must have been not less than one month in the Colony at the date of the application for the subsidy.

(3) Every importer of pedigree or grade animals, in respect of which it is intended to claim the subsidy, shall give one month's notice in writing to the Director of Agriculture of his intention to import, and shall state the number of animals to be imported.

(4) When applying for the subsidy, the importer will be required to state the country of origin and in the case of pedigree animals the particular herd or stud in which each animal is registered and to attach a certified copy of the pedigree or of the pedigree transfer certificate of each animal. In the case of grade animals the importer will be required to attach a certified copy of the heifer calf registration certificate.

(5) Before payment of the subsidy, each animal must have passed all quarantine regulations under the Animals Importation Ordinance 1886, and have been admitted to the Colony.

(6) The subsidy will not apply to animals which, in the opinion of the Government, have been imported for the purpose of sale. An importer who has been paid a subsidy or subsidies in respect of an animal or animals imported by him and who sells those animals within one year from the date of importation shall be liable to refund the whole or part of the subsidy.

(7) The total amount of subsidy payable to any importer in any calendar year shall not exceed £100.

(8) These Rules shall take effect from the first day of June, 1930.

FREIGHT RATES.

3. The freight rates on cattle imported from New Zealand by Union Steam Ship Company's steamer are as follows:—

Bulls	£8 10 6 each
Bulls (yearlings)	6 1 0 ,,
Cattle 1, 2 or 3 head	5 10 0 ,,
Cattle 4 head	5 4 6 ,,
Cattle 5 head	4 19 0 ,,
Cattle 6 head or more	4 13 6 ,,
Calves up to 9 months	One-third off cattle rates
Calves under 1 month	Free.

PRE-SHIPMENT CONDITIONS.

4. Cattle imported from New Zealand must be accompanied by—

(1) a statutory declaration by the shipper giving a description of the animals and certifying—

(*a*) that the animals have been free from disease during the six months preceding the date of shipment;

(*b*) that they have not been in contact with any diseased animals during the six months preceding shipment and giving the name of the district in which they have been during that time;

(*c*) that they have not, otherwise, than is required by (2) below, been tested with tuberculin during the two months preceding shipment;

(2) a tuberculin test certificate by a qualified Veterinarian endorsed by the Chief Veterinary Officer of the Department of Agriculture of the State concerned. The certificate shall state (*inter alia*) the date on which the test was applied;

(3) a certificate from a Government Veterinarian or Veterinarian employed in an official capacity by a local Government authority stating—

(*a*) that he has examined the animals within seven days of shipment and found them to be free from disease; and

(*b*) that they have been dipped or thoroughly sprayed within thirty-six hours of shipment with a standard arsenical anti-tick solution, the name of the preparation to be given;

(*c*) that the agglutination test for contagious abortion has been applied with negative results within fourteen days of the date fixed for shipment.

QUARANTINE.

5. Cattle imported from New Zealand are required to undergo a period of quarantine of seven days. The regulations provide that they shall be dipped whilst in quarantine.

NOTICE OF IMPORTATION.

6. They may be imported through the port of Suva only. *The importer is required to obtain, not less than one month prior to the date of arrival of the cattle, the written permission of the Superintendent of Agriculture to import.*

FEES AND OTHER CHARGES.

7. Inspection and other fees payable in the Colony are as follows:—

Wharfage	1/6 per head
Port and Customs Service Tax	1 per cent. of value
Inspection Fees—	
For one and not exceeding four head ..	£1 1/-
For every additional head over four and not exceeding fifty	2/-
For every additional head over fifty ..	1/-
Transport Fees—	
For each trip of the cattle punt from the ship to the Quarantine Station ..	10/-

Dipping Fees—

Cattle over six months old	5/- per head
Cattle six months and under	1/- per head

When six or more cattle are imported by any person at any one time, reductions will be made in the dipping charges as follows:—

Numbers.	*Reduction in Fees.*
From 6 to 10	10 per cent.
From 11 to 20	20 per cent.
From 21 to 50	33⅓ per cent.
Over 50	50 per cent.

Upkeep and Sustenance Charges whilst in Quarantine—

Cattle one to four (per head)	3/- per diem
Each animal above four (per head)	1/- per diem.

EXAMPLES:

8. The total charges connected with freight, wharfage, inspection, transport, dipping and sustenance would be, on the rates shown above (which are subject to alteration), as follows: (Port and Customs Service Tax is not included as it is not possible to calculate the charge without the value of the animals being known):—

One Adult Bull from New Zealand: *Subsidy on one pedigree bull on conditions already stated*				£10
Freight	£8	10	6	
Wharfage	0	1	6	
Inspection Fee	1	1	0	
Transport Fee (if no other stock on board for transport to the Quarantine Station)	0	10	0	
Dipping Fees	0	5	0	
Sustenance Charge, 7 days at 3/- per diem	1	1	0	
	£11	9	0	
One Yearling Bull from New Zealand: *Subsidy*				£10
Freight	£6	1	0	
Wharfage	0	1	6	
Inspection Fee	1	1	0	
Transport Fee	0	10	0	
Dipping Fee	0	5	0	
Sustenance Charge	1	1	0	
	£8	19	6	
Six Pedigree or Grade Cows or Heifers over 9 months of age—				
Subsidy in respect of pedigree animals				£60
Subsidy in respect of grade animals				£30
Freight at £4 13s. 6d. each	£28	1	0	
Wharfage	0	9	0	
Inspection Fees	1	5	0	
Transport Fees	0	10	0	
Dipping Fees	1	7	0	
Sustenance Charges	4	18	0	
	£36	10	0	

Twenty Pedigree or Grade Cows or Heifers over 9 months of age—

Subsidy in respect of pedigree animals (limit)				£100
Subsidy in respect of grade animals (limit)				£100
Freight at £4 13s. 6d. each	£93	10	0	
Wharfage	1	10	0	
Inspection Fees	2	13	0	
Transport Fees	0	10	0	
Dipping Fees	4	0	0	
Sustenance Charges	9	16	0	
	£111	19	0	

Twenty Pedigree or Grade Heifers under 9 months of age—

Subsidy pedigree animals (on attaining 9 months) (limit)				£100
Subsidy on grade animals (on attaining 9 months) (limit)				£100
Freight at £4 13s. 6d. less ⅓	£62	6	8	
Wharfage	1	10	0	
Inspection Fees	2	13	0	
Transport Fees	0	10	0	
Dipping Fees (over 6 months)	4	0	0	
(Six months or under the charge would be 16/-)				
Sustenance Charges	9	16	0	
	£80	15	8	

FIJI LIVE STOCK RECORD ASSOCIATION—MINUTES OF MEETING.

MEETING HELD ON 11TH JULY, 1930.

Present.—Director of Agriculture (Chairman), Senior Veterinary Officer, G. Kiss, Esq., and J. Barber, Esq.

Owing to an oversight R. Craig, Esq., was not advised of the meeting.

The minutes of the last meeting were read and confirmed.

The Chairman drew the attention of members to an article on livestock in Fiji prepared by the Senior Veterinary Officer for publication in the *International Register of Pedigree Stock Breeders*, and stated that a copy would be made available to members for perusal on application.

The Chairman stated the action taken by the Government towards assisting importers of pedigree and grade stock and stated that a memorandum on the subject would be distributed in due course.

The Board directed that an effort be made to exhibit a list of the members of the Association, particulars of animals registered, &c., in the Agricultural Department's exhibit at the Suva Show. The Secretary was instructed to take the necessary steps to carry out this instruction.

Mr. Kiss suggested that the Association should open a Calf Register and that animals registered therein should not be transferred to the main Register until after they had been inspected and passed as suitable for inclusion. The Board directed that this matter should be considered at a later meeting.

CONTENTS.